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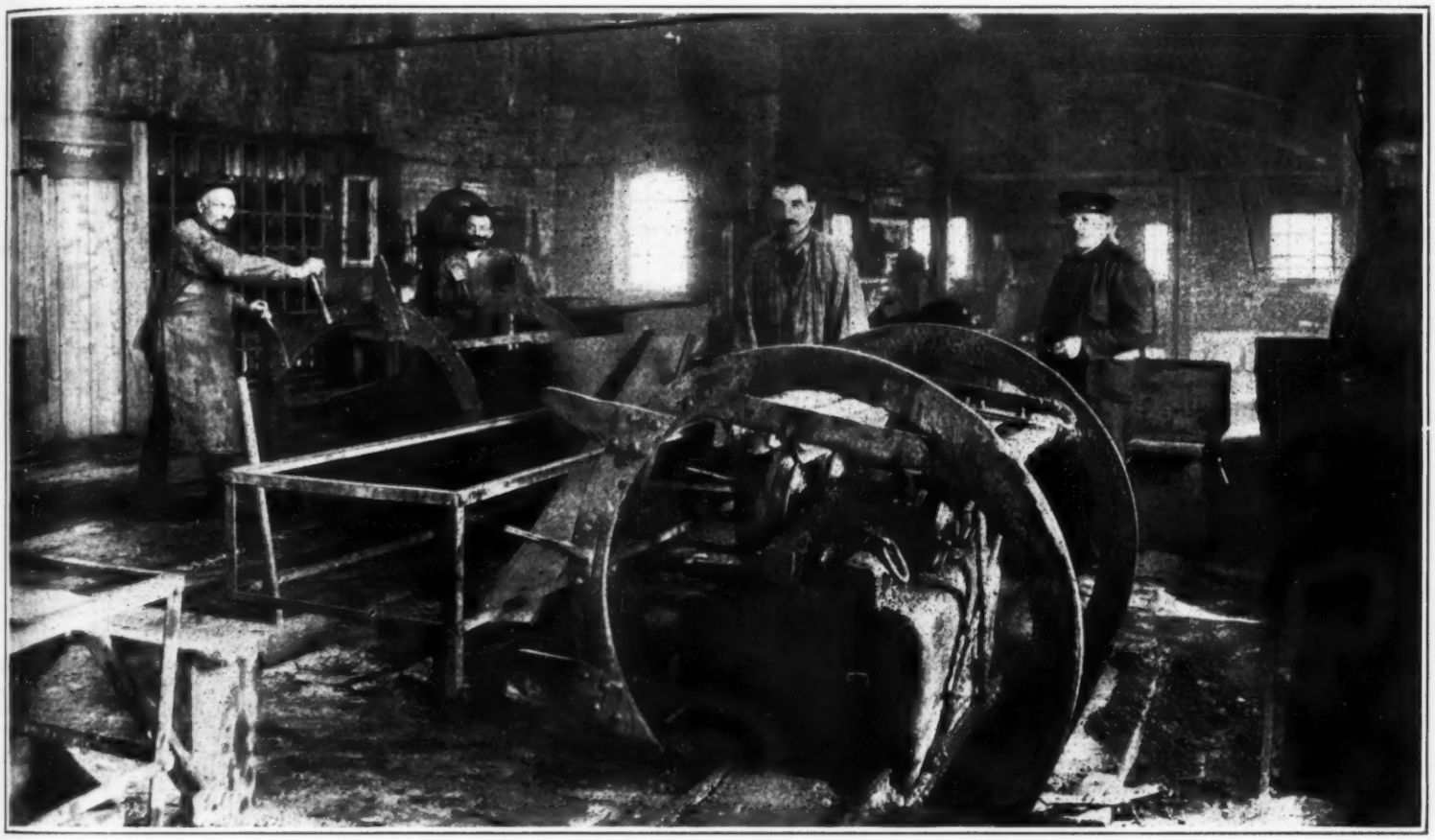
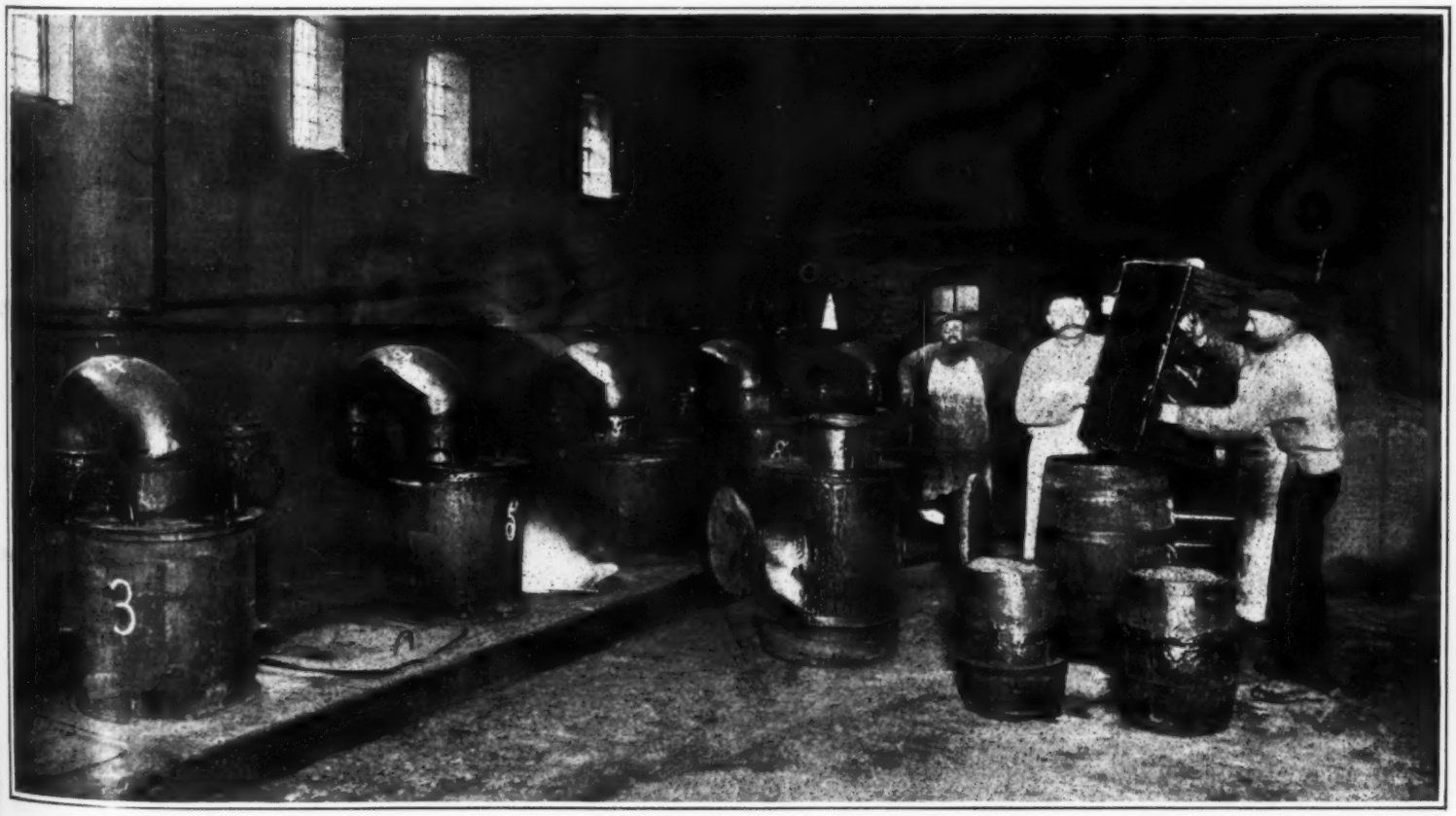


Rocker on which the cars of "blue earth" are tipped, discharging their contents into the washer.



The parings obtained in cleaning and smoothing crude amber are used for making varnish.

AMBER FISHERIES AND AMBER MINES.—[See page 346.]

Building Large Gas Engine Flywheels*

Details of the Construction Methods Employed for Twelve 85-Ton Wheels for 3,600 Horse-Power Units

By J. H. B. Bryan

WHILE the writer was employed by an Eastern concern manufacturing large pumping and gas engines, a contract was secured to furnish twelve 3,600 horse-power gas engines. Six of these were blowing engines and occupied a floor space of approximately 40 by 100 feet, while the remainder were power engines occupying 60 by 80 feet. The engines were built in duplicate parts, thus saving a large amount of shop erection.

The flywheels of the engines were made in eight segments, two half plate hubs with segments secured to the hubs by twenty-four 4-inch taper bolts and at the radial joints of the rim by four shrink links and a screw dowel. The wheels were 24 feet in diameter and weighed approximately 85 tons. The boring and facing of the hubs were separate operations and the machine work was all done to gage. For planing the segments, two fixtures, *b*, Fig. 1, were provided for chucking the pieces. The faces *l* were planed to the exact angle and chord of the segment. The keyways *f* were put in the bottom of each fixture corresponding with the bolt slots in the planing machine platen *h* and doweled with four gib headed keys *c* for giving a quick and positive adjustment when the fixture with the segments was moved from one position to another as the work progressed. The posts *i* and *j* were planed to a known dimension lower than the finished top surfaces of the segments and were used as a rest for parallel feelers for adjusting the cutting tools to remove the required amount of stock to an accurate finished dimension of the segments. The faces *l* were used for guidance in machining the radial joints for the segments. The fixtures were arranged so that both the side and cross rail heads of the planing machine could be used. The first operation on the segments consisted of planing the radial joints of top surfaces of the hub end and two spots on the rim and the radial joint, the last of which are shown at *d*, Fig. 1, and *q*, Fig. 2, to facilitate the following operations. In the second operation the bolt holes were bored to two different diameters, leaving the smaller one for opposing surfaces for washers in securing the segments to the block *e*, Fig. 1, and lower hub plate, Fig. 2. A special jig having side flanges guided to position by the angles of the hub end of the segment was used in connection with the vertical boring bar for this operation. The segments were then mounted on the block *e*, Fig. 1, parallel with finished block *d*, and were ready for the final planing machine operation. The block is made to allow the hub end of segment to overhang at the sides, thus giving free access for gaging.

All the members of the flywheel are now ready to be assembled on fixtures arranged in order as shown in Fig. 2 on a concrete floor. The bottom plate *j* and the companion plate *f* have holes corresponding in number, radius and pitch to the bolt holes in the hub and are used for bearing supports to the boring bar *g*, the plate *f* being doweled to the hub by the pin *s*. The hole for this pin is located in the line of the keyways in the hub and when these are cut the dowel holes, of course, disappear. The stands *r* are located and pitched to the centers of the radial joints of the rim. Bearing plates are placed parallel to the finished spots on the rim *q* and the plate *j* is centered and lined to the stands *r*. The bearing holes in the plates *f* and *j* and the hub are brought in perpendicular alignment by shaft, having a tapered socket fit in base, which in turn has a dowel fit to a bar

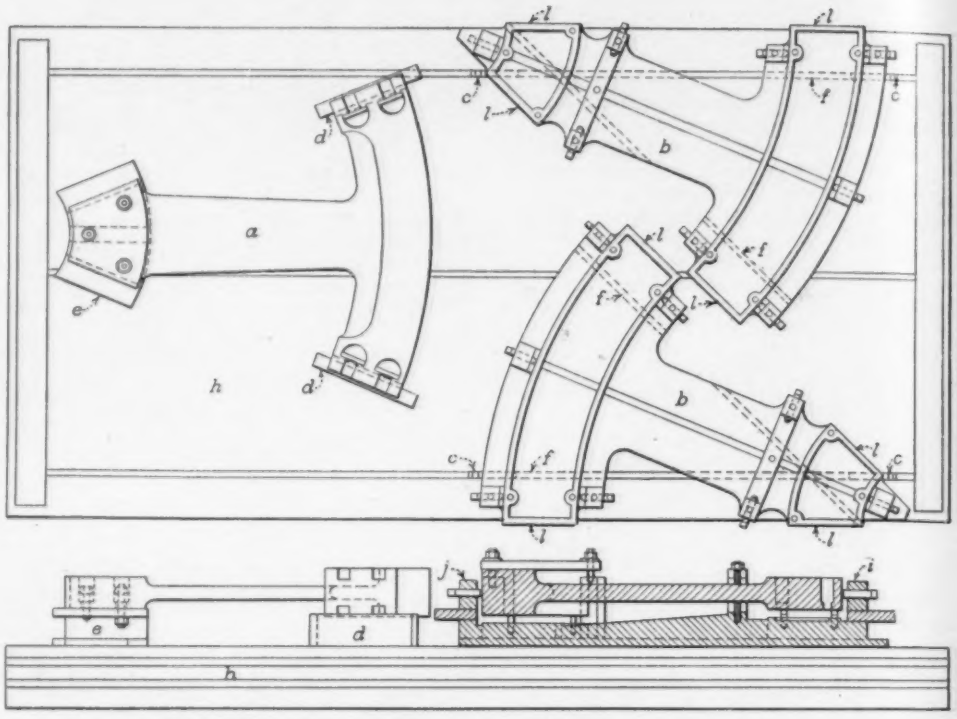


Fig. 1.—The segments of the wheel mounted on the planing machine.

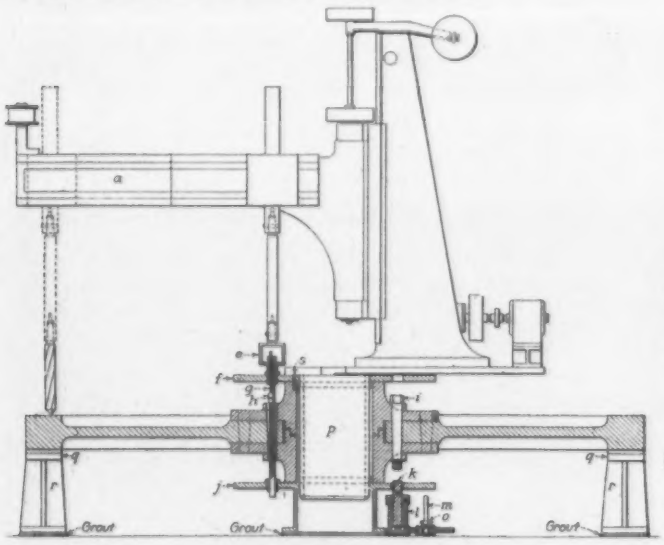


Fig. 2.—Arrangement of radial drill for boring bolt holes in segments.

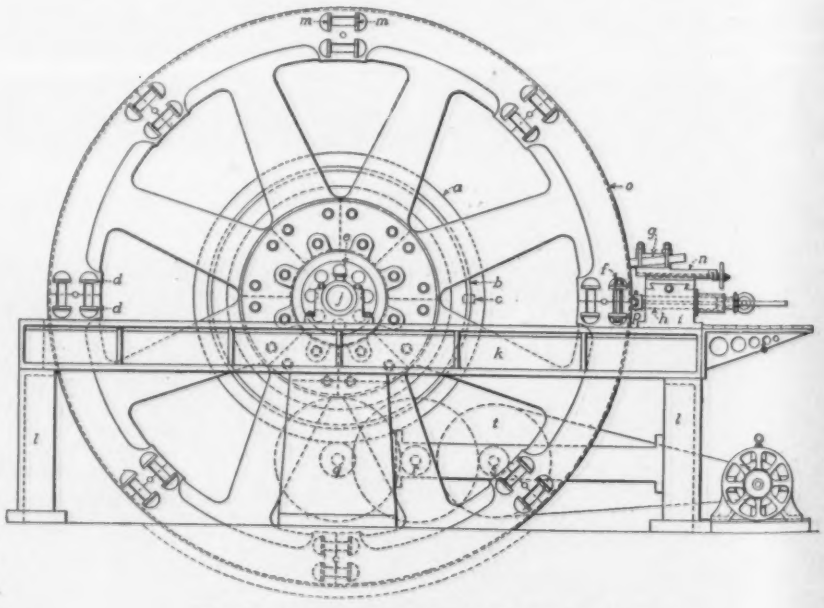


Fig. 3.—Facing and turning the rim in a special machine.

*Reproduced from *The Iron Age*.

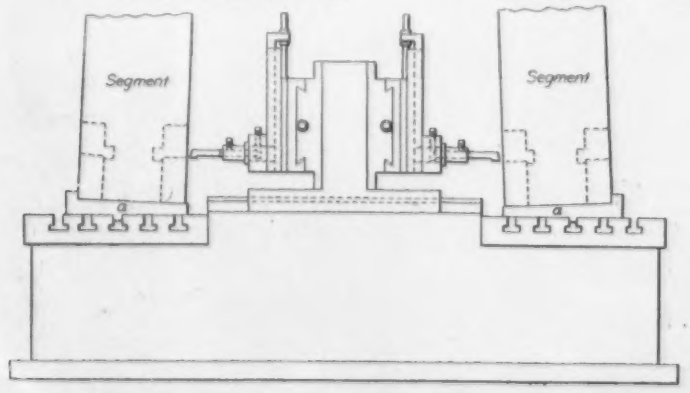


Fig. 4.—Method of mounting the segments on a shaping machine which cuts on forward and return strokes.

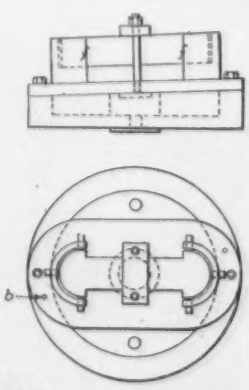


Fig. 5.—Detail of the fixture for holding the links in a slotting machine.

supporting hole in the plate *j*. For convenience a radial drilling machine having an extended arm, *a*, mounted on a rotary base, *p*, is employed to drive the boring bar, *g*, and the drill for screw dowels in the rim. A standard boring bar of suitable dimensions is employed for a second roughing of the holes which are finished with the bar *g*. The construction of the wheels called for bolts having a taper of 1/16 inch per foot and the bar had a dovetail slot, sloping 1/32 inch per foot from the lower end of the bar. A tool block having a slot for carrying the boring tool and operated with a screw feed was fitted in this slot. Automatic screw feed was used with a ratchet on the drive end of the screw in the yoke *e* with a ratchet to feed the screw and when the bar *g* rotated the ratchet handle came in contact with the stationary tapped pin and a pull back spring produced the feed. The regulation of the feed was accomplished by adjusting the tapped pin giving short and long strokes of the ratchet. For quick return of the tool block, a sheave was used on driving end of the feed and was operated with a turn of a belt lacing by a see-saw movement of the hands.

The performance of this boring arrangement was remarkable for accuracy, and it was seldom that a reamer was employed and then only for holes having sand spots. The standard dimensions of bores for holes were obtained by tool steel trams partly encircling the bar with a contacting point for the boring tool that represents the diameter of the holes. In use these trams rested upon the hub at the terminals of the large end of the holes. After both holes were bored and the drilling and tapping of the screw dowels were completed, the drilling machine and the plate *f* were removed. The next operation was fitting the bolts *i*, and in anticipation of this operation the bolts were practically completed and fitted to collar gages, leaving a small amount of stock for the final fitting. An engine lathe mounted upon wheels and a conveniently located jib crane for handling the bolts were found economical expedients. The bolts were driven to within a predetermined distance from the heads with a 20-pound sledge and were driven home with a battery ram at the final erection. In fitting the bolts in position it was found very difficult to back them out with ordinary means, and for this purpose an air jack, *l*, was used, having a plunger with a soft metal head, *k*. Moving the operating lever *m* of the three-way cock *o* caused the plunger to ascend and strike vigorous blows that soon loosened the bolts. This jack was also used in driving the temporary hub bolts for the turning and facing operation, shown in Fig. 3.

The opposing surfaces are machined to undercut dimensions. The method of machining the surfaces *m* is novel and interesting, and is shown in Fig. 4. This represents a shaping machine that cuts on forward and return strokes, the wedges *a* having a taper corresponding with the undercut slope of surfaces *m*, Fig. 3. Fig. 5 is a fixture for holding the links before they are machined on a slotting machine. These links are secured to a table that is free to revolve on a dowel fit to a base having a slope corresponding with the undercut and held in place by the dowel pin *b*. The hub members of the segments are mounted on a bushing, *e*, Fig. 3, for the mandrel *j*. The segments are then assembled, the hub bolts driven and the rim secured with screw dowel bolts *f* and washers, and the wheels are now ready for the turning and facing operation. To take care of the vibration of the rims which is present in handling such a large piece of work, a steady rest was made by tooling a groove, *o*, on the outside face of the rim with a round nose tool. The hardened dummy *g* secured in the tool box of slide rest *n* was fitted in this screw, which when well greased met all the requirements of a steady rest while the two bars *h* are facing the sides of the rim. When the facing of the side was completed the tool bars with wooden rubbers in the tool slots *p* were employed to steady the rim, while the outside diameter was being turned. The flywheel machine shown in Fig. 3 was designed and built by the writer with a view to varying the beams *k* to suit the machine operations of a variety of flywheels and kindred members. The slide rest has two tool bars *h* independent of the saddle that carries the upper slide rest *n*. The tool bars are fed independently of each other. The driving mechanism consists of a large gear, *a*, centered on the mandrel *j* and having a face for bolting angle drivers near the outer diameter with a circular bolt slot, *b*, and an enlarged opening, *c*, to admit bolts to the slot. The pinion *q* meshes with the gear *a* and the gears *r* and *s* and the driven pulley *t*, which is belted to the motor, complete the drive.

The keyways in the hub were made 1/8 inch less in width than the keyways in the shafts to take care of distortion in the keyways after the hubs were pressed on the shaft and were opened out to proper dimension by the use of drift tool placed in the key slot and guided by the keyway in the shaft. The cutter was fed by shimming and the operation made a keyway for side bearing fit of keys. The time saved in fitting the keys with the tool more than paid for the cost of making it.

Stability of Ships' Lifeboats

A PAPER on "Life-saving Appliances" was read recently by Sir John H. Biles, Professor of Naval Architecture at Glasgow University, and a prominent member of recent Commissions on Safety of Life at Sea, in the course of which he discussed the relative advantages of the open and decked types of lifeboat for ships. He pointed out that open lifeboats, crowded with passengers, would by no means be certain to survive in ordinary Atlantic weather, and said that it was the expressed opinion of experienced commanders of mail steamers that the dangers of launching boats from large vessels in rough weather were no greater than the dangers from capsizing after they were launched in the same weather. He even went further by saying that if the weather were rough enough to make launching of the boats difficult, it would also be rough enough to prevent them from surviving long with their heavy cargo. It is not surprising, therefore, to find that the drift of his suggestions was in favor of the decked type of lifeboat, which, he said, could be made practically unswampable and uncapsizable by some improvement of the present design.

The nature of the improvements which are desirable, in Sir John Biles's opinion, are that the bulwarks which are now collapsible or folding, should be made permanent and water-tight, and that water-tight tanks should be fitted in the angle between these bulwarks and the deck—in addition to the present air-tight space below the deck—and also presumably at the high ends of the boat, so that she may be self-righting. He also advocates the fitting of some arrangement for rapidly and automatically clearing the boat of water which may break on board. With these additions and alterations, he considers that the decked type of lifeboat would be practically unsinkable and uncapsizable, a condition of things much to be desired if full value is to be obtained for the undoubted additional expense to shipowners of carrying boats for all. It is obvious that unless the compulsory boat equipment is designed to be adequate to the usual conditions of emergency, there is little justification for the financial burden involved in carrying it.

In this connection, it is interesting to note that some very valuable investigations concerning the stability of lifeboats have been made in the United States of America, and the results embodied in a paper read before the Society of Naval Architects and Marine Engineers in New York last December by Professor H. A. Everett, of the Massachusetts Institute of Technology. Four boats were used in the experiments made, representing the four main types of ships' lifeboat now in use. Two were open boats, one made of metal, the other of wood, and both were of the same external dimensions. The third was a decked lifeboat of metal with folding bulwarks and without side or end tanks, and the last was a collapsible boat, or pontoon, with extensible canvas bulwarks which are usual with such boats, if boats they may be called—they are really only life rafts with a little shelter provided for the passengers. All four boats were new, and had been obtained direct from the makers. They were, as nearly as the variations of design would permit, of the same size, that is 28 feet long. All were lifeboats, that is to say, the open boats were fitted with buoyant tanks of standard capacity, under the thwarts, those of the metal boat made of galvanized iron and having 76.4 cubic feet capacity, and those of the wooden boat made of copper with a cubic capacity of 51.8 feet. The decked boat was air-tight below the deck, and she was constructed of metal, while the collapsible boat was of wood, with the space between her decks filled with buoyant material, as is usual. The types were, therefore, quite representative of modern practice. The passenger capacity of the open boats, as fixed by the rules of the United States of America, was fifty persons, including crew, that of the decked boat sixty, and that of the pontoon fifty-four.

The boats were all loaded with sand bags to represent passengers, the positions of the centers of gravity of the bags being made to represent accurately the normal loaded condition. Inclining experiments were made in perfectly still water, so that the actual positions of the centers of gravity might be positively determined. Stability calculations were also made for many angles of heel, and curves of statical and dynamical stability plotted with the corresponding righting arms. The results showed that the open boats had a continually increasing righting moment until they reached such an angle that the water came over the rail, 30 degrees for the metal boat and 32 degrees for the wooden one; at these points, of course, the boats founder. The stability curves were of the normal shape for a ship-shaped form, but that for the metal boat was greater than that of the wooden boat. This was caused partly by the relative positions of the centers of gravity of the two boats when unloaded, and partly by the height of the seats for the passengers. In the wooden boat, both height of center of gravity and height of thwarts were slightly greater than in the metal boat. A more important fact was that a very considerable increase of stability was obtained by seating one third of the occupants upon the floor of the boat instead of on the seats. From this experiment it was calculated that if the thwarts had been placed 6 inches lower there would have been an increase of statical stability, with the passengers upon the seats, of about 40 per cent. This is a point worthy of note, for there appears to be no reason why it should not be done; it is a simple way of keeping the weights low, and a reduction of 6 inches in height would still leave the seats and thwarts 18 inches above the floor, which is ample for comfort. The angle of zero stability for the decked type of boat was less than that of the open boat, 27 degrees against 30 degrees and 32 degrees, but this would be reversed if the suggestion to make the bulkwarks water-tight were adopted.

In the case of the collapsible boat, or pontoon, figures for a standard boat are not available, because in the sample tested an extraordinary condition of things occurred. The boat was new, fresh from the makers' hands, obtained with the usual guarantee, and supposed to be in all respects ready for immediate service; and yet it became apparent soon after she was launched that water was getting into the space between the decks, which is filled with buoyant material and supposed to be water-tight. It was assumed that the shell of the boat had opened up through exposure to the weather. She was, therefore, hauled up and a few days allowed to elapse in which swelling of the wood might stop the leakage. On relaunching the same thing occurred, and as in such a form of construction there is no possibility of baling out the incoming water, it was impossible to remedy the defect easily. The pontoon sank with forty-three persons on board, although she was supposed to accommodate fifty-four. The number of passengers was then reduced to sixteen, and the point of vanishing stability was reached at 3 degrees of heel. The failure of this boat was undoubtedly due to water finding its way into the space between the decks, and becoming absorbed by the buoyant material, with which the space is filled for the express purpose of preventing such a large loss of buoyancy. This condition of things is a very vicious one, for not only is it impossible to detect the leakage at once, but when it is found out, there is no possibility of getting rid of it by baling. It is also more than likely that such a wooden construction would always be subject to similar fault, because of the unavoidable weathering to which the boats are exposed on the open deck of an ocean-going steamer. Since the experiments were made, the report of the United States of America Committee on Lifeboats, bearing date of October 13th, 1913, shows that this committee recommends that "collapsible boats or folding boats should not be allowed as any part of the required life-saving equipment." The space between decks of such a boat could be made permanently water-tight by using metal instead of wood in construction, but even then there is practically no freeboard, for the bulwarks are not intended to be water-tight, and while the curve of righting moment is steeper for small angles of heel than in ordinary boats, it quickly reaches the point of zero stability; it is, indeed, the curve of a raft and not that of a ship-shaped vessel at all. The great attraction of these collapsible boats is the ease with which they can be stowed; a nest of three or four, one above the other, takes up little more room than one ordinary boat, but if this convenience is purchased at the expense of reliability at a pinch, it is too dearly bought.

On the whole, then, there seems to be a balance of argument in favor of the decked boat—that is to say, of a boat with a water-tight compartment between the keel and a deck, say, 18 inches above it. This deck would be higher than the level of the water in which the boat floats in loaded condition. Self-emptying devices could be easily provided, and if, in addition to this, water-tight tanks were fitted along the side and at the ends in such a way as to make the boat self-righting, and the bulwarks were made water-tight instead of collapsible, we should have a type of boat which would have a chance of living in any sea in which it could be successfully launched from the ship which carried it.—*The Engineer.*

Launch of the battleship "Oklahoma."

Launch of torpedoboat destroyer "Downes."

This Year's Additions to Our Navy

Super-dreadnoughts "Texas" and "New York"; Torpedo-boat Destroyer "Downes"; Electric Collier "Jupiter"

By L. B. Ward

THE United States stands third in the world's naval armament—this takes into consideration those vessels now under construction as well as those completed. For a number of years she stood second, but Germany has forced her way into second place, although our naval appropriation for the fiscal year 1913 was second to Great Britain's. However, it is a well-known fact that the United States pays more for what it gets than any other nation.

Our Navy has now twenty-four battleships of the pre-dreadnought type, ten completed dreadnoughts and four under construction. Great Britain has forty pre-dreadnoughts, nineteen dreadnoughts, with fourteen more under construction; Germany, twenty pre-dreadnoughts, thirteen dreadnoughts, and six under construction.

The opening months of the new year brought four new vessels to our Navy: two super-dreadnoughts, the "Texas" and the "New York," a torpedo-boat destroyer —the "Downes"; and "Jupiter," the new electrically driven collier; each being the "last word" in her class.

The contract for the "Texas" was signed by the Newport News Shipbuilding Company December 17th, 1910; her first keel plate was laid April 17th, 1911, and one year later, May 18th, 1912, she was launched.

The "Texas" is the largest warship in our Navy in commission, and the most formidable fighting craft ever completed by any power up to this time. She is 573 feet in length, overall; breadth, on load water-line is 95 feet 2½ inches; mean draft 28 feet 6 inches; normal displacement 27,000 tons. Her battery is the most powerful in the Navy—the 14-inch guns carried by her are the largest carried by any vessel. She has ten 14-inch 45-caliber guns; twenty-one 5-inch 51-caliber guns; four 3-pounder saluting guns; four 21-inch submerged torpedo tubes. It is claimed that she can outrun, outshoot and outfight anything of her size afloat.

The trials of the "Texas" took place between the 22nd and 30th of October, 1913, on the Government-measured course at Rockland, Maine, when she exceeded her contract speed of 21 knots.

The "Texas" is fitted with two vertical, inverted, direct-acting, four-cylinder, triple-expansion, reciprocating engines, placed abreast in two separate water-tight compartments. The cylinder diameters are: high-pressure, 39-inch; low-pressure, 63-inch; two low-pressure, 83-inch, by 48-inch stroke; 125 revolutions per minute; steam-pressure (by gage) at high-pressure steam-chest, 265 pounds; collective indicated horse-power of both engines, 28,000.

There are fourteen water-tube boilers of the Babcock and Wilcox type, arranged in four separate boiler-rooms. Eight of these boilers are fitted with super-heaters. Total grate surface, 1,554 square feet; total heating surface (not including super-heating surface), 62,215 square feet; total super-heater surface, 3,267 square feet; working pressure, 290 pounds.

She has a 5-kilowatt 500-cycle radio set.

The "Texas" was turned over to the Government February 15th, 1914, complete to the last detail. Her full complement is 65 officers and 1,000 men.

The "New York" was recently completed at the Brooklyn Navy Yard, and is now in the Gulf of Mexico. She is a sister ship of the "Texas," 27,000 tons' displacement, and carries the fourteen-inch guns also. She was launched October 30th, 1912, and her contract date of completion was May 1st, 1914.

The contract for the torpedo-boat destroyer "Downes" was awarded the New York Shipbuilding Company at Camden, N. J., September 8th, 1911. She was launched from the ways in their yards on November 8th, 1913, and christened "Downes" in honor of Captain John Downes, highly distinguished in the war with Tripoli. In 1814 he was executive officer on the "Essex" during her engagement with the British frigates "Phoebe" and "Cherub" in Valparaiso harbor, and when in command of the Pacific squadron he was most active in suppressing the attacks of the Malays on American merchantmen, for which he was highly commended by Congress.

The "Downes" is 305 feet 3 inches in length; breadth on load water-line is 30 feet 5 inches; mean hull draft, 9 feet 7 inches; normal displacement, 1,072 tons. She has two masts and four funnels.

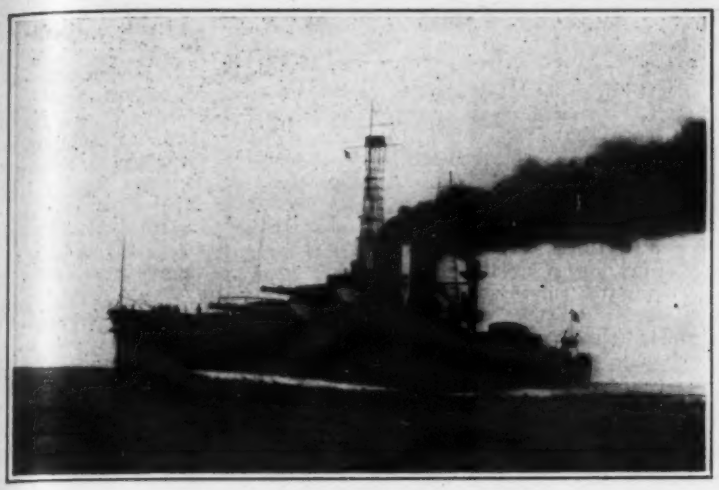
She is a twin-screw Curtis turbine vessel; the two Curtis turbines having 16,000 collective shaft horse-power. Forward of each of these Curtis turbines and connected to it by a clutch coupling, is a compound reciprocating engine, to be used for the lower cruising speeds. Steam is supplied by four Thornycroft boilers, two in each fire-room, having a total heating surface of 26,000 square feet. No super-heaters are fitted. She has a designed speed of 29 knots, and is expected to easily meet this requirement.

Her battery consists of four 4-inch 50-caliber rapid-fire guns and four twin 18-inch torpedo tubes.

Her complement will be 5 officers and 93 men.

The United States collier "Jupiter," the first electrically driven sea-going vessel ever built, was constructed by the Government at the Mare Island Navy Yard, at San Francisco. She is the largest ship ever laid down on the Pacific Coast. This twin-screw vessel is driven by a pair of induction motors, which receive their energy from a variable-speed turbo-generator. This scheme of propelling vessels of large size was developed by W. R. L. Emmet, of the General Electric Company, and makes possible simple control, direct from the bridge or wheelhouse, to regulate the speed forward or backward or stop.

The generating unit for the "Jupiter" consists of a six-stage Curtis turbine connected to a bipolar alternator, the speed of this unit at 14 knots being about 2,000 revolutions per minute, and the voltage about 2,200. The generating unit delivers its output to two motors, one mounted directly on each propeller shaft. The motors have 36 poles; therefore, the ratio of speed reduction is 18 to 1, the propellers being designed to operate at 110 revolutions per minute. The generating unit and motors are self-lubricating and self-ventilating; metal ducts are connected to their air outlets so that the heated air will be led to the suction of the fire-room blowers, and not be released in the engine-room. There is a switchboard equipment which embraces oil switches for connecting the motors for rotation in either direction, also instruments to show and record the electric power delivered to the motors. Two water-cooled resistance devices are placed in circuit with the revolving elements of the motors during the process of reversing; these are connected by sliders on the motor shafts, operated by levers, attached to the motor frames. The equipment is so designed that the greatest power delivered by the generator does not greatly exceed the actual requirements of driving the ship; this does away with destructive trouble arising from wrong connections. As extra precaution, interlocks are so arranged that wrong connections cannot be made. The go-ahead switch and the reversing switch cannot be closed at the same time and neither switch can be closed until the resistance is in circuit with the motor secondary. Magnetic locks are provided for the levers which throw the resistance in and out of circuit, energized from the field circuit of the generator, thus the levers are prevented from movement until the generator has lost its field magnetism, and the possibility of burning of contacts by movement at wrong time or manner prevented. Speed changes are not made by throttling, as is usual with ship turbines; this turbine being equipped with a governor, so arranged that it is capable of holding the speed at any point, from 5 knots up to the maximum; the setting of the governor is controlled from a point near the switchboard and operating levers. The engineer can, without change of position, run the ship at any desired speed ahead or reverse, can start or stop, and also see the speed and power delivered to the propellers; while still in this same position he can close the main throttle valve by hand, or trip it so that it closes instantly. The generating unit also has an automatic device which trips the main throttle in case the speed of turbine exceeds a certain limit. While the turbine is controlled by this novel governor, it is not dependent on it, but can, by a simple disconnection, be operated by the throttle from a point near the switchboard and motor levers. All of the parts are accessible and can be replaced easily, extra parts being carried on the vessel so that no lengthy in-



Battleship "Texas" on her trial trip.

Battleship "New York."

terruption to service can occur. The turbine having six stages, in event of the loss of blades in one or more of these, can be so arranged to operate on the remaining stages without any renewals, that any one of the six stages will propel the vessel above half speed.

Simplicity is the keynote of the entire scheme. The method of transmitting the electric power used is the most simple form known. The entire equipment is rugged and of the kind thoroughly tested by long established usage for great varieties of purposes on land, under more difficult conditions, and has been proven perfectly satisfactory. The switching apparatus is of a standard type easy to repair or replace, and, if necessary, could be removed and the ship operated by temporary connections.

The "Jupiter" was launched August 24th, 1912. She is 542 feet in length and 65 feet in breadth. Her mean draft loaded is 27 feet 8 inches. Displacement 19,360 tons. Cargo capacity for coal, 10,457 tons; bunker capacity, 2,043 tons. Cargo capacity for oil, 2,932 tons.

The "Cyclops" and "Neptune" are sister ships to the "Jupiter," having the same displacement; the "Cyclops" is equipped with triple-expansion reciprocating engines; the "Neptune" with a pair of steam turbines with gear reduction to bring the high speed of her turbines down to a workable and economical basis.[1]

The "Cyclops" in a 48-hour test run averaged a speed of 14.6 knots at 92 revolutions per minute, consuming only 1.485 pounds of coal per indicated horse-power per hour. In the preliminary trials of the "Jupiter" during November she met all her requirements. She completed the 48-hour run with an average speed of 14.78 knots per hour, which is more than three-quarters of a knot above her designated speed. Captain F. M. Bennett was in command, and the trial took place off the Santa Barbara coast. It is thought in her official tests that she will even better this record. As she was tuning up for her official trials a loose bolt dropped into the turbine, damaging her to some extent, and it was deemed prudent to put into the Mare Island Navy Yard for repairs before running off for trial.

The "Jupiter" is an experiment in naval construction, and her history will be watched with interest in comparison with her sister ships "Cyclops" and "Neptune."

A comparison table is herewith given, embracing the principal features:

	Cyclops.	Jupiter.	Neptune.
Displacement, in tons	20,000	20,000	20,000
R. P. M. at 14 knots speed	88	2,000	1,250
Propeller R. P. M. at 14 knots speed	88	110	135
Ton weight of driving machinery	280	156	.....

The General Electric Company furnished the entire equipment for the electric transmission.

The "Oklahoma," launched on March 23rd, at the yards of New York Shipbuilding Company, at Camden, N. J., and her sister ship, the "Nevada," now under construction, will be larger than the "Texas" and "New York," having a displacement of 27,500 tons, and a length of 583 feet. They will have the same battery as the "Texas" and "New York," carrying ten 14-inch guns, twenty-one 5-inch guns, and four submerged torpedo tubes. The armor belt is 13½ inches thick and will extend 400 feet along either side of hull, 8½ feet below and 9 feet above water-line. Two protective decks to guard against plunging fire are, respectively, 3 inches and 1½ inches. The "Oklahoma" will burn oil, which will be carried in her double bottom, eliminating any necessity for coal bunkers. Her engines have an indicated horse-power of 24,800, and her speed will be 21 knots.

The "Pennsylvania," under construction at the Newport News Shipbuilding Company, and vessel No. 39 under construction at the New York Navy Yard (to be named "Arizona" or "North Carolina"), are very much larger than any former vessels. The displacement of the "Pennsylvania" is 31,400 tons and of No. 39 is 31,500—a little larger than her sister ship. They will carry twelve 14-inch guns, three in each turret. Commander Gleaves, of the Navy Yard, says that No. 39 will be launched in less than ten months from the date of laying her keel—March 16th—and will establish a record in naval construction.

[1] The machinery of the "Neptune" is fully described on page 348.

The Power Required for Refrigeration*

Its Dependence on the Temperatures Employed

By John J. Smith

THE use of artificial refrigeration for industrial purposes has increased to a great extent in the last two decades, and with the development of chemical industries of various kinds, is undoubtedly destined to increase much farther.

Under these circumstances it is very necessary for those interested in such industries to know what the cost of such refrigeration will be, or, at least, what power it will require.

Engineers are very generally accustomed to thinking and calculating in units of horse-power, but relatively few of them are sufficiently familiar with refrigeration to be able to calculate, from the refrigeration required, the horse-power necessary. It is to supply, at least in part, this deficiency that the present article is written.

In the year 1906 the Iron and Steel Institute of Great Britain published a paper by J. E. Johnson, Jr., on which the present article is founded. This paper pointed out the connection as shown by thermodynamics between the quantity of refrigeration, the temperatures involved and the theoretical horse-power required, and then gave a method for determining the factor by which the latter must be multiplied to give the actual horse-power needed, based on the best data then available, notably the publications of Prof. J. E. Denton, on that subject.

Within quite recent years, however, the York Manufacturing Company, under the guidance of its general manager, Mr. Thomas Shipley, has conducted an enormous number of scientific tests, working under widely varied temperature conditions, and has determined the quantity of refrigeration, the pressures of ammonia, the temperatures corresponding, and the horse-power developed in the steam cylinders of the compressors for each set of conditions. These tests they have been liberal enough to publish in their catalogue, so that the information is accessible to anyone.

When these data came into my hands I thought it would be interesting to check up the earlier work of Johnson and see whether his type of equation for the conversion factor between theoretical and actual results was correct. The results seem to me of sufficient importance to publish.

For the benefit of those who have not seen the earlier article above mentioned, it may be well to explain briefly the formula which connects quantity of refrigeration and power requirements, but first it is necessary to point out a curious condition which has grown up in the refrigerating industries.

The earliest refrigerating machines were put in to take the place of refrigeration with natural ice. As a result they were all rated in tons of "ice melting effect," that is, a "ten-ton" machine would do the same amount of refrigeration as the melting of 10 tons of ice directly applied.

The heat absorbed by ice in melting is a perfectly well known and definite quantity, 142 British thermal units per pound, or 284,000 British thermal units per ton, and since refrigeration furnished by ice must be applied at the unvarying temperature of melting ice, 32 deg. Fahr., no other factor than quantity of heat to be absorbed need to be considered. It was like pumping water from one lake with a fixed level to another at a higher level. Quantity was the only variable factor.

But with artificial refrigeration all this is changed because the temperature of application of the refrigeration may be anything from 50 deg. Fahr. above zero to 50 deg. Fahr. below zero, and the power required for a given quantity of refrigeration varies greatly according to the temperatures between which it is performed.

To utilize our illustration again, it is like pumping from different wells, the water level of some at the surface, that of others, hundreds of feet below it. Height in this case becomes a factor whose variations are as important as those of quantity. But this change, so important not only in thermodynamics, but also in practice, has been frequently overlooked, and until recently it was customary to give the capacity of a refrigerating plant in "tons," with little or no attention to the temperatures involved. This, of course, is precisely the same as giving only the quantity of water pumped in our second illustration without stating the difference of level through which it was raised.

It is hoped that this article will not only serve as a convenient means of enabling the power required for a stated amount of refrigeration to be determined for the given conditions, but that it will make clear to all the direct and vital connection between the power required and the temperatures involved, and will show the direct application of thermodynamics to this subject.

All students of thermodynamics know that the formula $\frac{T_1 - T_2}{T_1}$ is reversible and applies in theory just as much to refrigeration as it does to development of power from heat. T_1 and T_2, in this case, are the temperatures at which the heat is received and discharged from the working substance, exactly as it is in the same formula for a heat engine, but in this case the heat is received at the lower temperature and discharged at the higher

* Reproduced from *Metallurgical and Chemical Engineering*.

one, therefore, T_2, in this case, is the lower, and T_1 the higher temperature, thus being the opposite to the case of a heat engine.

Any quantity of heat "Q" measured in British thermal units per minute is converted into foot-pounds by multiplying by the mechanical equivalent of heat, 778, and this, in turn, is converted into horse-power by dividing by 33,000. Of this quantity Q the percentage transferred between temperatures $T_1 - T_2$ is given by the formula of thermodynamics

$$\frac{Q\ (T_1 - T_2)}{T_1}$$

and this, in terms of horse-power, becomes

$$\text{H.P.} = \frac{778}{33{,}000}\, Q\, \frac{T_1 - T_2}{T_1} = 0.0235\, Q\, \frac{T_1 - T_2}{T_1}. \qquad (1)$$

The capacity of refrigerating machines being given in tons per twenty-four hours, this is reduced to thermal units per minute (Q) by multiplying by 284,000, and dividing by 1440, the number of minutes in a day. Thus, 197.+ British thermal units per minute equals 1 ton of refrigeration per twenty-four hours. Therefore, if we have the temperatures between which a given refrigerating machine works and the number of tons of refrigeration that it performs, we can readily figure the theoretical horse-power required and can then compare this with the actual. The basis on which to make such a comparison is obviously on variations of $\frac{T_1 - T_2}{T_1}$. Accordingly, this quantity has been calculated for a number of the tests whose results are given by Mr. Shipley, and also the ratio of the actual to the theoretical horse-power required for the same tests. These have been plotted in the diagram, Fig. 1.

Abscissæ are values of $\frac{T_1 - T_2}{T_1}$, ordinates are ratios of actual to theoretical horse-power.

It will be observed that a line can be drawn through the points, touching, or almost touching, most of them and passing through the point

$$R = 1,\ \frac{T_1 - T_2}{T_1} = 0$$

exactly as in the article by Johnson, though these data are more complete than were available to him. The equation of this line is

$$R = 1 + 3.7\, \frac{T_1 - T_2}{T_1}, \qquad (2)$$

in other words, the excess of the power actually required over that theoretically necessary increases in exact proportion to the increase in $\frac{T_1 - T_2}{T_1}$, or, roughly speaking, it increases in proportion to the temperature difference, which is precisely what we should expect from our knowledge of the conditions.

Comparing this with the formula derived by Johnson from Denton's results, we find that he had

$$R = 1 + 4.15\, \frac{T_1 - T_2}{T_1}$$

The difference between 4.15 and 3.7 represents the increase in the efficiency of refrigerating machines since Denton's tests were made.

It is proper to point out also that the results given by the York Manufacturing Company are not the exact power requirements under test conditions in each case, but are about 10 per cent greater, so as to represent simply reasonably good operating conditions.

It is believed that this formula will be a tool of real usefulness in the hands of those who will take the trouble to use it. If an engineer has the problem of cooling a given quantity of gas or liquid, or solid, through a given temperature in a given time, he can generally find a reasonably accurate value for the specific heat without much difficulty. This will enable him to figure the number of thermal units per minute to be removed. The temperature to which the given substance must be cooled will, of course, be known as one of the conditions of the problem. The temperature of the cooling water available, either from a natural source of from artificial air cooling, controls the temperature of the ammonia condensers T_2 in the formula. The latter temperature will always be about 10 to 15 degrees higher than the former. Similarly the ammonia in the cooling coils must be carried to a temperature about 10 degrees lower than that of the substance to be cooled, if direct cooling is used, or about 20 degrees lower if the ammonia is used to refrigerate brine, and this, in turn, is used to cool the substance under consideration. These, of course, are conditions almost as various and as numerous as the problems to be solved.

But if the temperature of the ammonia condenser and of the ammonia in the cooling coils be known or determined, and the quantity of heat to be removed be known, then the power required for the purpose in good standard practice can be calculated from the formula given above with all needful accuracy for industrial purposes.

For illustration of the above principles: certain reactions will only take place below certain temperatures, or

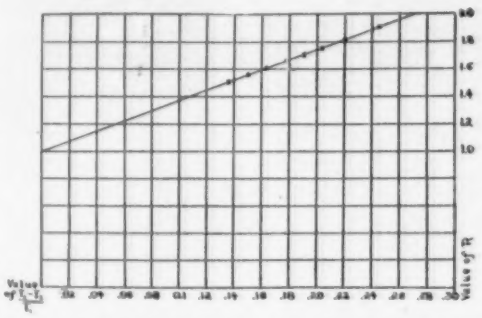


Fig. 1. - R is ratio of 1 h.p. of steam cylinder of ammonia compressor to theoretical or dynamic h.p. for different values of $\frac{T_1 - T_2}{T_1}$ plotted from Shipley's tests.

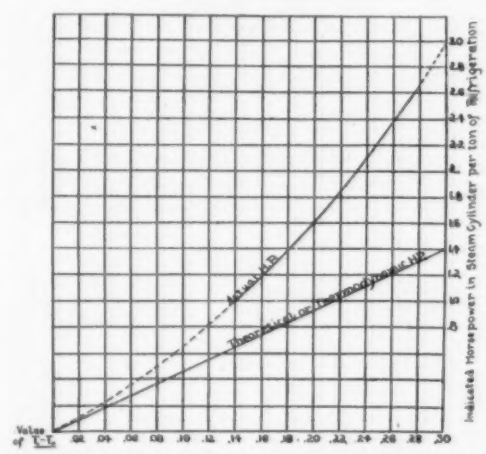


Fig. 2. – Smith refrigerator, showing theoretical and actual horse-power required per ton of refrigeration for different values of $\frac{T_1 - T_2}{T_1}$

if the temperature gets too high the consequence may be disastrous, as in the case of the manufacture of nitroglycerine. How much power is required to keep the temperature below the critical point?

In such a case the amount of heat evolved per unit weight of material is accurately known or can be accurately determined, and, of course, the weight of material is given. The temperature below which the reaction must be carried on has been found by experience.

Let us assume, in the case of nitroglycerine, that the latter is 50 deg. Fahr., and let us assume that the quantity of nitroglycerine to be manufactured is such that the heat to be removed below this temperature is 10,000 thermal units per minute. Let us assume that it is necessary to use brine in the circulating pipes because the acid used in nitrating would attack iron or steel pipes, which are virtually the only ones that can be used for carrying ammonia. In order to force the heat through the walls of the pipes, let us assume that we must have a 12-degree interval of temperature for each set of pipes; that is, the brine must be 12 degrees lower than the nitrating tank, and the ammonia 12 degrees lower than the brine. The temperature of the ammonia then becomes 26 deg. Fahr. Let us assume that cooling water is available at the warmest period of the year at 72 degrees, and that the corresponding temperature in the ammonia condensers is 85 degrees.

It may be well to state here that I am not familiar with the details of the manufacture of nitroglycerine, and the above assumptions are not supposed to be based on actual conditions; they are merely used for purposes of illustration.

For this case T_1 becomes $26 + 460 = 486$, and T_2 becomes $85 + 460 = 545$. $\frac{T_1 - T_2}{T_1}$ becomes 0.121, for which the value of R from the formula or chart is nearly 1.45.

The theoretical horse-power required, based on formula 1, in which Q becomes 10,000 and $\frac{T_1 - T_2}{T_1}$ has the value stated, is 28.6. Multiply this by 1.45, we obtain as the actual horse-power required in the engine cylinders, 41.4. This reduces the problem to terms with which engineers are perfectly familiar.

When this article had been completed to this point, it was realized that a still further simplification of this matter was possible, because both the theoretical horse-power required and the ratio R, by which it must be multiplied to give the actual horse-power, depend solely on $\frac{T_1 - T_2}{T_1}$. If, for convenience, we call this latter quantity Z, we have from (1) denoting by hp, the theoretical horse-power,

$$hp = .0235\, Q\, Z,$$

and from (2)

$$R = 1 + 3.7\, Z.$$

Denoting by H. P. the actual horse-power we have

$$\text{H. P.} = R \times hp = 0.0235\ Q\ Z\ (1 + 3.7Z).$$

This obviously gives: $\text{H. P.} = 0.0235\ Q\ (Z + 3.7\ Z^2)$

It is obvious from this formula that when the quantity of refrigeration Q and the temperatures are known, the horse-power required can be determined very readily by calculation.

But it can be still more easily obtained from a chart, plotted according to this formula, which is given herewith. The straight line marked "theoretical, or thermodynamic horse-power," gives the horse-power per ton of refrigeration per twenty-four hours required according to thermodynamics. The parabola tangent to this line at the origin and rising rapidly above it, gives the actual horse-power required per ton of refrigeration in any given case, according to the results of Mr. Shipley's tests and to the formula herewith.

Taking the value of $\frac{T_1 - T_2}{T_1}$ equal 0.121, in the case given above, we find the horse-power per ton from the chart to be 0.82. The quantity of refrigeration required in tons is the British thermal units per minute (10,000) divided by 197, or 51. This multiplied by 0.82 gives us 41.4, exactly as before, without the use of any formula whatever.

The portion of the actual horse-power curve, represented by the solid line on the diagram, is that based on actual tests. The dotted portions at the ends are plotted from the formula, assuming it to be correct for temperature ranges higher and lower than those given.

From what has been said above, it will be seen that this is probably more than the reduction of empirical data to a graphic form, and that not only formula (1) but probably also formula (2) represents with close approximation a natural law, since it implies that the losses in a refrigerating process are closely proportional to the temperature interval involved, which is in line with our general knowledge of such matters.

It seems not amiss to point out that this actual horse-power curve emphasizes a law which refrigerating engineers understand thoroughly, but which has not always been realized by others, and that is that the power required for performing a given amount of refrigeration increases enormously with the temperature-interval involved, and for that reason all refrigeration should be done at as high a temperature, be as direct, and involve as few tranfers of heat from one medium to another, as the conditions of the given case will permit.

The Relation of Aquatic Animals to the Surrounding Water*

How Our Blood Bears Evidence of Our Ultimate Aquatic Origin

By Prof. G. G. Scott

Did you ever wonder why fishes do not get drowned? Or how they can breathe in the water, which, after all, is really the same question as the other? Or how it is that they do not keep drinking water all the time? Or why a salt water fish dies in fresh water and *vice versa*? I am not going to answer these questions at all, but instead will discuss a bit of dry physics and chemistry as a proper setting for what appears to me to be a fascinating story, throwing interesting light on the origin of our own species.

When two gases are confined in the same vessel, they mix or diffuse into one another. Thus light hydrogen gas will diffuse downward into heavy carbon dioxide

* By permission of the New York Zoological Society.

and the latter will diffuse up into the light hydrogen. A similar behavior is observed when two solutions of different substances are brought into contact. Diffusion between the two continues until the concentration throughout the vessel is everywhere the same. The driving force by which this result is obtained in the case of solutions is called *osmotic pressure* and is measurable.

One of the most characteristic features of living things is that substances must pass to and fro between the external world and the living cell in order that that cell may obtain energy for its work and get rid of its waste substances. The cell wall is a membrane separating the living substance within from the material outside, and through this there must be an incurrent and excurrent stream of materials.

In the lower aquatic animals the entire body is surrounded by water and the substances which the cell needs are in solution. Although the simplest forms may take food particles directly into the cell, yet it soon occurs, in the evolution of more complex forms, that the cell can absorb its food in liquid form only, and if the food at hand is not in liquid form the cell secretes a solvent which changes the solid food into the form of a solution. In higher animals with many organs composed of a multitude of cells, the blood carries the food in soluble form to all the various cells of the body. But these substances had first to get into the blood, and in every step they must pass through membranes. So we observe that there is a constant and repeated passage of materials in and out through membranes formed of cell walls.

We said above that when two solutions of different concentration, or of different osmotic pressure, were confined in the same vessel, the molecules undergo a change of position until finally a condition of equilibrium is attained. If we stretch a permeable membrane across this vessel, dividing it into two compartments, and place a solution of low osmotic pressure in one and a solution of great osmotic pressure in the other, a condition will soon obtain in which the osmotic pressure will be the same on both sides of the membrane. This process probably plays a great part in the life of the cells of the body. The degree of permeability of cells to various substances has been the subject of much investigation.

The waters of the ocean contain solutions of salts of various kinds, one of the principal salts, as everyone knows, being sodium chloride, or common salt. Now the osmotic pressure of ocean water is a little over 22.4 atmospheres, the pressure of one atmosphere being 15 pounds to the square inch, so the driving force of the molecules in such a solution is very large. The Mediterranean Sea is saltier than the ocean, hence the osmotic pressure, about 28 atmospheres, is greater even than that of the ocean. The Black and Baltic seas receive a great deal of fresh water, and hence are less salty than the ocean, and so the osmotic pressure of these waters is less than that of the open ocean. The water of New York harbor is very dilute, due to the great volume of water flowing in from the Hudson River, and the osmotic pressure is only a little over one half that of ocean water. Distilled or pure water of course contains no salts in solution, hence its osmotic pressure is zero. The osmotic pressure of spring water or river water is very small, being less than half an atmosphere. When pure distilled water is taken in great quantities into an empty stomach, we have a solution of no osmotic pressure bathing the walls of cells, whose osmotic pressure, in the human being, is about 7 atmospheres. The great difference in osmotic pressures causes injuries to the cells. The small amounts of salts present in our drinking waters are just sufficient to counteract this. The harmful effect of eating snow and ice is relevant to this action, since snow and ice are practically frozen distilled waters.

Now aquatic animals inhabit all the waters of the earth, which present a great degree of variation as far as the content of dissolved salts is concerned, and therefore of their osmotic pressures. What is the relation of all the various groups of aquatic animals to the external medium? As far as we can say, the osmotic pressure in the cells of an animal is probably the same as that of the blood, which can be easily measured. Now, aquatic animals could adapt themselves to the osmotic pressure of the water in various ways. For example, they could construct membranes at the surface of the body in such a way that these membranes would be absolutely impermeable to the external medium. In the second place, all parts in contact with the water could be freely permeable so that the interior of the cells would be practically living matter or protoplasm permeated with the water and with its salts in the same proportion as they exist in the water. Or, thirdly, some of the parts in contact with the water could be freely permeable and other parts less so.

Undoubtedly the first animals were formed in the sea and the same salts were present in this primeval living organism as are found in the sea and in the same proportions. Even in the jelly fishes, which are somewhat complex animals, this is true, and they are in perfect osmotic equilibrium with the sea. Later arose animals like the crustaceans with their hard external parts. They have certain structures which protect them from the sea without, yet even here also, on account of the permeability of other parts, the blood is in osmotic equilibrium with the sea water. While in higher forms, like the mollusks and the crustaceans, the animal is not as freely open to the sea as is the jelly fish, nevertheless the blood has the same osmotic pressure as that of the sea water. For example, if we studied these animals from the Mediterranean we would find that the osmotic pressure of the blood is like that of the water from that sea. In the more dilute waters of the Baltic the blood has the same concentration as that of the water outside. Moreover, it has been shown experimentally that the osmotic pressure of the blood changes according to the external medium.

Now, of course, there are limits to which this change can take place. We might say that living matter is so constructed that its activities can be manifested only within a certain range of external conditions. The osmotic pressure of the human blood is quite constant at about 7 atmospheres. The osmotic pressure of the blood of the marine invertebrates along our shores, as we have seen, is equal to about 22.4 atmospheres, and is even higher than this in the case of those forms found in the Mediterranean and much lower in those found in the Baltic. The range of osmotic pressures which the blood of these lowly forms may take and yet be compatible with life is large.

If, as we have said, the blood of these forms becomes modified—i. e., more dilute as the external medium is made more dilute—water must get into the blood of the animal or the salts of the more concentrated blood of the animal must get out. It is probable that both changes take place. But through what part of the body? Three possible structures have to be examined. These are the skin on the surface of the body, the wall of the intestinal tract and the gill membranes. Observation and experiment show that it is probably through the gills that the exchanges usually take place—for example, when an oyster is "fattened" by being placed in fresh water, water enters and salts leave the oyster through the gills, with the result that the oyster swells up.

Oysters sometimes grow in very brackish or even fresh water. This is explained by the fact that marine invertebrates placed in a medium differing in density from that to which they are accustomed, immediately respond by losing salts and taking on water to the end that soon their osmotic pressure is near or the same as that of this external medium. Of course, if they were placed at once in fresh water they would die, but it is quite possible that, by subjecting some of these invertebrates to successive small reductions in the density of the water, we could finally get them to live in fresh water.

Biologists tell us that the sharks and skates are among the lowest of the fishes. In the osmotic pressure of their blood they resemble the marine invertebrates. That is, it is the same as that of the external medium. The blood of sharks from the Mediterranean is more concentrated than that from sharks of the more dilute Atlantic Ocean. However, extensive experiments have shown that while these animals resemble their invertebrate ancestors in this respect, the change is not as great as that which occurs in invertebrates under the same conditions. In a certain series of experiments carried on by the present author it was found that the changes induced in the osmotic pressure of the blood of dog-fishes were about one fourth of the magnitude of the changes made in the external medium. A shark would, of course, be killed in fresh water.[1] I found that the osmotic pressure of the blood of dog-fishes in the New York Aquarium was distinctly lower than that of dog-fishes from Buzzards Bay, where the water is much more concentrated than the dilute harbor water in which the fish live at the Aquarium. But the blood of these Aquarium dog-fishes would not have as low an osmotic pressure as that of invertebrates living in the same water. (This conclusion is drawn from what we know of the behavior of the invertebrates and not from actual observation.) The point is that the sharks and shark-like fishes are to a certain extent independent of the osmotic pressure of the external medium, whereas the invertebrates have little if any means of protecting themselves.

But what shall we say of the marine bony fishes (cod, mackerel, etc.) which, in contrast with the sharks and marine invertebrates, have an osmotic pressure of the blood considerably less than one half of the sea water in which they live? Important changes in the blood have taken place, and in these fishes the gills have become practically impermeable barriers to the more highly concentrated outside medium. In spite of the fact that the sea water has an osmotic pressure of over twice that of the blood of these fishes, the diffusion of its salts is prevented. The parts of the body exposed to the sea water of such high osmotic pressure are constantly bombarded, so to speak, by the high pressure without. The scales covered with the slimy membrane effectually prevent the changes taking place through the skin, the wall of the intestinal tract is equally efficient, and the gill membranes, through which the gaseous exchanges must still take place between the blood and the water, are so modified that they also act as barriers to the high salt pressures without. In our study of the osmotic pressures of the blood we find no connecting links between the conditions found in sharks and those found in the bony fishes.

It has been found that the osmotic pressure of the blood of fresh water bony fishes is slightly less than that of the salt water forms. The fresh water streams and lakes, in all probability, became inhabited by forms which had their original home in the sea. In this adaptation the blood has become slightly modified from the condition found in the marine bony fishes. This would go to show that, whereas the bony fishes are practically immune to the ordinary high external pressures, yet extreme changes in these would produce some effect. Thus I found that the blood of the tautog living in brackish water at the New York Aquarium had an osmotic pressure slightly less than that of the same fishes living in the more concentrated waters of Buzzards Bay. Furthermore, if the bony fishes are affected in no way by the changes in the osmotic pressure of the external medium, then we would expect that the blood of the anadromous bony fishes, which go from the sea to fresh waters or back again, would remain practically stationary under these changed conditions. But this is not the case, for, as Greene found in the case of the Chinook salmon, the blood has a slightly lower osmotic pressure in the fresh waters of the spawning beds as compared with that in sea water. Dakin in England found the blood of the eel in fresh water slightly different from that of the same species in the sea. I have noted a similar condition in the white perch. The osmotic pressures of the blood of these forms is not quite as high as that of exclusively marine nor as low as that of exclusively fresh water forms.

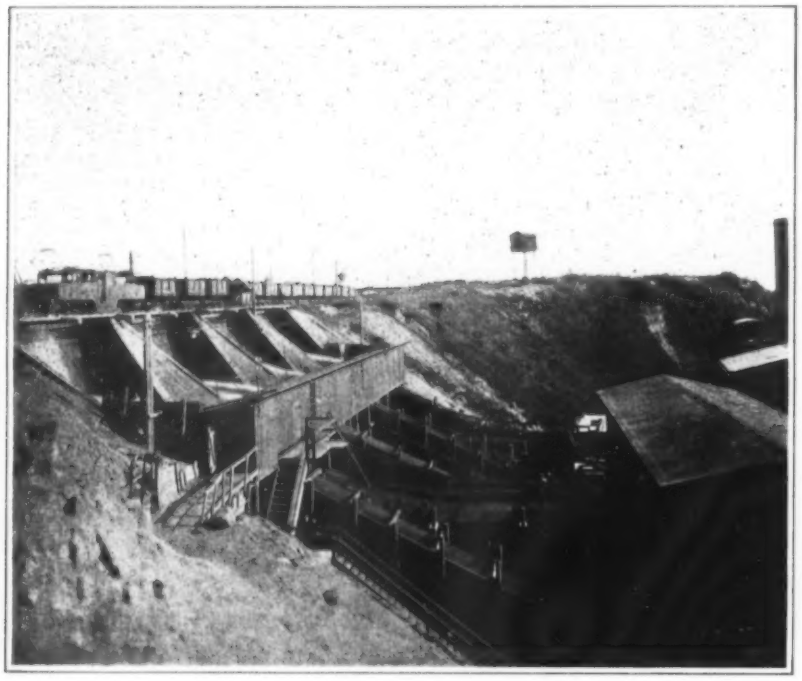
The amphibians (or frogs, toads and salamanders) are fish-like in the tadpole stage, and have about the same osmotic pressure of the blood as the fresh water fishes. It is of great interest to note that, when they emerge from the aquatic stage to lead a terrestrial life, they take with them on the land the same kind of blood which was developed in their fish-like bodies. We suppose that the reptiles arose from the Amphibia, and reptilian blood has an osmotic pressure quite similar to that of the frogs. The birds and mammals were divergent lines of evolution from the reptiles, and the osmotic pressure of the blood is similar to that which preceded. In this way we can explain the presence of salts in our own blood to-day. It is an inheritance carried along through all the ages during which the living world has evolved. It came about in the first place in the creation of living matter in the sea, and the salts of the sea played, and to this day play, an important part in the processes which we call living. Prof. A. B. MacCallum has shown that our blood to-day contains the same salts in the same proportions as they existed in the seas of primeval days.

It becomes continually more evident that to properly understand man and the other mammals we must study the lower forms, too. Scientists have already devoted a great deal of attention to structures; they will give more attention in the future to the study of the evolution of living processes.

[1] It must not be forgotten that one species of shark (*Carcharias nicaraguensis*) occurs in Lake Nicaragua in absolutely fresh water. R. C. O.

Transportation of Chemicals by Water

In *Chemiker-Zeitung*, 38 (1914), 146, J. Aeby discusses the above problem from the point of view of the transportation expert in the light of the lessons learned from the "Volturno" disaster. In the English investigation of this accident it appeared that barium peroxide was the original cause of the fire; therefore, there is, the author believes, danger that this product will be boycotted and its transportation by water surrounded with difficulties, as is already the case with sodium and potassium peroxide. Admitting that barium peroxide was the primary cause, he however points out that the fire would never have occurred unless this substance had been shipped with inflammable organic substances. Since it cannot be expected that transportation companies and steamship lines shall have expert chemical knowledge of the goods they carry, the author considers it the duty of shippers, in their own and the public's interest, to advise the transportation companies as to the nature of goods shipped, so that, for example, neither peroxides nor permanganates shall be shipped in the same cargoes as inflammable organic substances, liable to react with such chemicals.—*Journal of Industrial and Engineering Chemistry.*

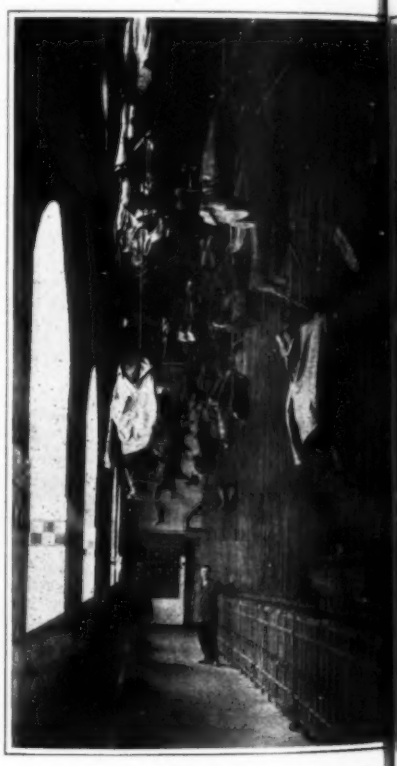


The ore-washing plant of the surface mine.

Home workers returning pared amber together with the scrap.

Each

After a storm the fishermen gather on the shore and "fish" for amber drifted in by the waves.

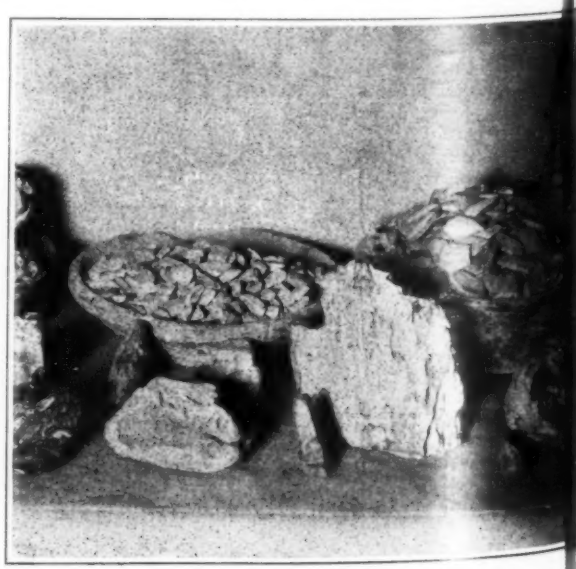


The workmen's clothes are hung on cables.

Ornamental

Horse-cars used in the underground mines.

Turning amber on the lathe.



Samples of crude amber.

Automa

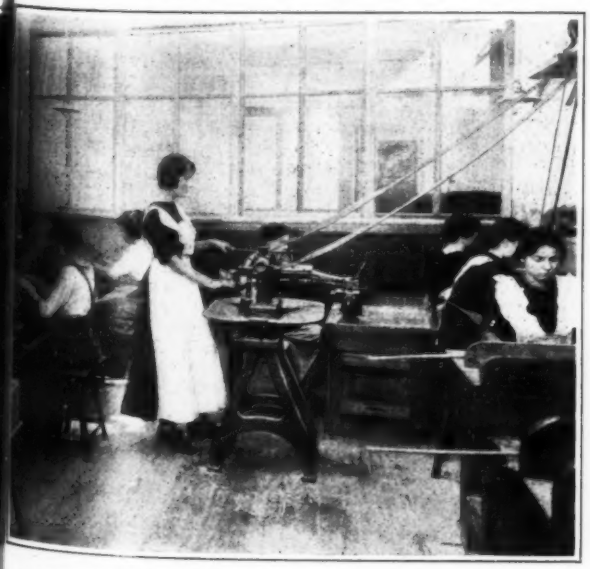
AMBER FISHERIES AND AM

Each miner is inspected before leaving, to prevent theft of amber.

The government mine, Anna, near Palmnicken.

Ornamental column made from pressed amber.

Baltic fishermen returning with their spoils from an amber "fishing" expedition.



Automatic amber grinders operated by women workers.

Washing the amber free from the "blue earth."

Mechanical digger used for surface mining.

AND AMBER MINES

Amber Fisheries and Amber Mines

How the Fossil Resin is Gathered and Worked Up Into Ornaments

By M. v. Jakubowski*

The majority of minerals used as gems are of inorganic origin, and accordingly do not contain the element carbon. There are however a few notable exceptions. The element carbon itself furnishes two items on the list, namely the diamond, whose precise origin is unknown, and jet, a species of very hard coal, probably derived from the fossilization of coniferous wood. Of carbonates used as personal ornaments we have the pearl and the variously tinted coral. And again there is the fossil resin amber, the "electron" of the Greeks, which especially in antiquity enjoyed popular favor. The chief source of amber remains to-day, as of old, the Baltic coast.

Years ago, before the definite occurrence of amber as a mineral in the so-called "blue earth" was discovered, "fishing" for amber was a fairly remunerative side line in the industry of the Baltic fishermen.

After a storm they would drag their nets through the waves breaking at the shore, and gather a very respectable harvest of amber, usually entangled in the drifting seaweed. A particularly rich catch was made after the great flood tide of the first month of this year, which did so much damage on the coast, but brought a good harvest to the fishermen. The lumps picked up vary in size. The largest piece on record weighs 18 pounds; such large specimens are of course of very considerable value. An offer of $5,000 for a piece weighing 13 pounds was refused.

The legal status of the amber industry is peculiar: The Prussian government has placed the refining of amber under a monopoly, and all finds must be delivered to the government works. The fishermen receive a cash payment for the value of the amber brought in by them. The regulations are so strictly enforced that other firms do not dare to purchase from the fishermen.

As noted above, the recovery of amber from the sea is merely a side line with the fishermen. The bulk of the amber obtained at the present day is mined in the government mine Anna at Palmnicken, both by surface and underground working. In this locality the coast forms a cliff of about 160 feet height. The surface (open) mines are protected from the waves by stone dams. Several shafts are carried down as far as the so-called blue earth, which occurs in a layer from 13 to 24 feet thick.

Ecclesiastical ornaments made of amber and dating from 800 A. D.

The underground mines form a fairly extensive system in which hundreds of miners are occupied. There are regularly timbered galleries, in which the men loosen the blue earth with pick and shovel, and collect in bags the amber thus exposed. Premiums are given for particularly good finds. The blue earth is carted up to the surface in horse-drawn cars. Their contents are then tipped out and a hose is played upon the material. The loose earth is thus washed away, leaving the amber deposited upon a grate. The amber is then washed and sorted. Each week a batch is sent to the Royal Amber works in Königsberg, where the amber is stored, sorted, carefully cleaned, and prepared for the market. There is also a plant for the manufacture of pressed amber.

The amber industry figures quite prominently in the social economics of Königsberg. No less than 500 women find constant home occupation by it. A weighed quantity of amber is handed out to each woman, and is then worked on in the home by all the women of the household.

The product together with parings is returned to the works, its weight being checked to guarantee correct delivery. The offal is used for making amber varnish.

A strict watch is kept at the mines, each individual workman being inspected as he leaves work. The hygienic equipment is strictly modern, with shower-baths, etc. Each workman has a wire cable allotted to him, on which he hangs his clothes and draws them up high, thus furnishing at once ventilation and protection against theft.

There is always a certain element of danger in mining operations. While the amber mines are fortunately not exposed to the danger of firedamp, still lives are lost occasionally from the collapse of galleries and so forth. For this reason the open mining has of late been particularly cultivated. A large bucket-chain digging machine loads the material dug up into railway cars, which convey it to a washer. As previously described, the earth is washed from the amber by streams of water, the mud being allowed to flow off into the sea, while the amber is left behind.

The amber obtained on the Baltic is not worked up at the Royal Amber works themselves, but goes into the hands of "amber turners," who fashion various articles of use and ornament from it.

Manual labor has of course to-day been replaced by machine work. Electric lathes turn amber mouthpieces, and automatic machines attended by women have taken the place of male workmen. The artistic taste of the gentle sex is turned to good account in the more artistic operations, such as stringing beads for necklaces, making bracelets, brooches, etc. The product goes out to all parts of the world.

* Photographs by the author.

Improvements in Radiotelegraphy and Radiotelephony—I*

A Review of Some Recent Patents

By W. H. Eccles, D.Sc.

The files of the Patent Office for the past year have shown, in a very impressive manner, that technical progress was continued with unabated speed in almost every branch of wireless telegraphy during the years 1912 and 1913. The following account of some of the most interesting patent specifications will help readers to form a fair estimate of the amount of achievement and of the direction of advance. It has not been possible to include all the patents worthy of attention, and in making the selection the writer has been influenced by his own predilection toward inventions that utilize novel principles or that push old principles forward in a scientific manner.

Perhaps the most striking and portentous improvement of all those recorded below is that associated with the use of the vacuum tube as a relay. A certain amount of information has already been published by von Lieben, de Forest and others. The specification set forth below gives an insight into the patent situation. Among apparatus for the transmission of signals there appears no epoch-marking novelty.

We will begin with apparatus used wholly or mainly at the transmitting station.

SENDING APPARATUS.

Miroslav Plohl describes in application No. 15,774/1912, a frequency changer which may be styled briefly a polarized transformer. Fig. 1 shows the essential principle simply. An iron ring, R_1, has two windings, G_1, connected to a supply of continuous current, W_1, to alternating current. During one half of the alternating-current wave the magnetic fluxes join up and, with small leakage, follow the iron path; during the other half of the wave the fluxes oppose each other, and there is great magnetic leakage across the air space within the ring. The leakage flux is always in the same direction across the air space. This is expressed graphically in Fig. 2, where the straight line g_1 refers to the continuous current, w_1, to the alternating current and m_1 to the magnetic leakage. Now, suppose a second ring arranged so as to produce a magnetic leakage in the same direction as the first, but alternately, the corresponding lines in the diagram are g_2, w_2 and m_2. Then if an iron core, wound as indicated in Fig. 3, be supplied, the secondary alternating current induced in the drum winding will be of double the frequency of the primary alternating current. Pieces of apparatus such as this may theoretically be arranged in cascade, but in practice one and the same apparatus is always used in combination with suitable tuning elements, as shown in Fig. 4.

W_1, W_2 are the alternating-current windings of two rings, S is the secondary winding, E an alternator with frequency n connected to windings W_1, W_2. The continuous-current windings are not shown. D is a choke coil for protecting the alternator. The conductor from S is connected to one terminal of each of the tuning elements A_1, A_3, A_2, A_4. The current of frequency n flowing in the windings W_1, W_2 produces current of frequency $2n$ in the secondary windings S; this passes through A_1 and back to the windings W_1, W_2, if the A_1 circuit is tuned to the frequency $2n$. The current of frequency $2n$ similarly produces current of frequency $4n$ in the secondary S, which finds its way through A_2, if the A_2 circuit has natural frequency $4n$; and so on till finally current of frequency $32n$ flows through the appropriately tuned primary circuit of the transformer T.

It should be mentioned that the inventor points out that by working the apparatus in the reverse direction it may be used as a receiver in wireless telegraphy or telephony. For this purpose the received oscillations are conducted into the alternating-current winding of the ring of Fig. 1 by aid of suitable tuning elements. Then there appears across the air space within the ring a unidirectional magnetic field which can affect either a polarized relay or a telephone diaphragm.

An application of the last invention is shown in a patent granted to the Gesellschaft für drahtlose Telegraphie (No. 14,390/1912). The problem is to produce alternating current of telegraphic frequency and of practical magnitude by means of the above static frequency-transformer. Experience has shown that for a wireless telegraph frequency of 40,000 per second the alternating current supplied to the transformer should be of frequency about 5,000 per second, and that a homopolar machine is the most suitable for generating this primary current. If the initial frequency is low and consequently many multiplications necessary, the static frequency transformer proves to be rather inefficient. The chief claim of the specification is for the use of a fairly high initial frequency with the static frequency transformer. Fig. 5 shows the arrangements adopted; they differ from those shown in the previous patent principally by the elimination of the special iron core carrying the secondary winding.

A series of patents taken out by W. Dubilier shows very clearly the development from small experimental beginnings of an ingenious method of producing electrical oscillations by means of compact apparatus. It is instructive to trace the line of development in spite of the fact that the inventor has, at certain points, been anticipated.

In specification No. 8,197/1912, the germ of the method arises, as it were, accidentally. In this, the leading conception is that the electrical oscillations which occur in the condenser usually connected across the spark-

* Reproduced from the *Electrician*.

gap of an inductorium may be utilized for reinforcing the oscillations generated in a circuit connected in the ordinary way to the secondary winding of the coil. Fig. 6 shows this very clearly. The primary of the inductorium 2, the interrupter 4, the cells 1 are connected as usual. The condenser 7 across the spark-gap has, in series with it, the primary 5 of another inductorium. The secondaries 3 and 6 of the two inductoriums are in series. Two gaps are shown, but they are provided merely to allow of one of the coils being put out of action when necessary. Ordinarily, in the operation of the apparatus, another single spark-gap

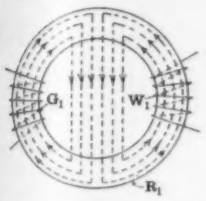


Fig. 1.

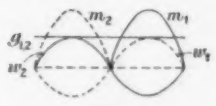


Fig. 2.

would be provided in series with any condenser and inductance connected with the secondaries. It is claimed that by this combination a larger percentage of energy can be transferred from the cells to the high-frequency circuit than in any form of Ruhmkorff coil.

The second specification of the series is No. 11,091/1912. The inventor points out that it has been the rule hitherto to form the sparks between stationary electrodes, or, at any rate, electrodes that remain a constant distance apart, and, in order to produce quenching, an airblast or a magnetic field or hydrocarbon vapor has been used. He proposes, in contradistinction to former

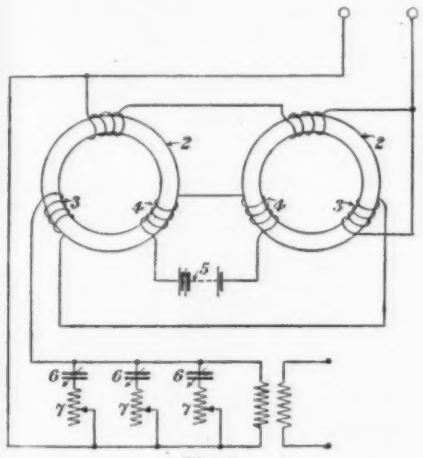


Fig. 5.

practice, to produce the spark (or arc) between electrodes which alternately approach and recede from each other. This lengthening and shortening of the discharge-path tends to the combination of certain of the merits of the oscillatory arc and the quenched spark; that is to say, undamped oscillations alternating with damped. The to-and-fro motion of the electrodes may be accomplished mechanically or electro-mechanically. Fig. 7 is a diagram of the arrangement of the circuits most suitable for use with this kind of discharger, and Fig. 8 shows the discharger itself. Here d' and d^2 are electrodes capable of motion, so that the gap d alternately lengthens and

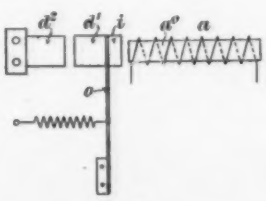


Fig. 8.

shortens; r a is a choking coil, f and e are condensers, g and c inductances. If the choking coil be made the winding of a magnet, as shown in Fig. 8, and the electrode d' be fixed to a spring, o, carrying an iron armature, i, the appropriate motion of d' may be accomplished as in the interrupter of an inductorium. As d' and d^2 separate, an arc forms, and is lengthened until it breaks, when the spring carries the electrode back toward d^2. The inventor specifies that the change of resistance of the arc is an essential feature of his method.

The third specification, No. 19,763/1912, is a patent of addition to that last described and describes mechan-

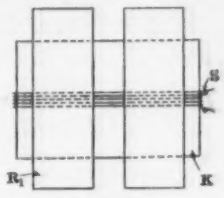


Fig. 3.

ical modifications appropriate to the case when the initial *P.D.* is sufficient to jump a small gap. One device illustrated in the specification is a rotating disk carrying a number of radial electrodes. For example, with 30 spokes and a speed of 1,500 revolutions per minute, 750 trains of oscillations are generated per second and a musical signal is produced. In the principal claim it is stated that the oscillations are such that they are undamped for a certain period and then damped for another period.

The fourth patent of the series, No. 16,917/1913, is more advanced in conception. The circuits are shown

Fig. 6.

in Fig. 9. The vibrator b has one electrode on the spring of an ordinary inductorium specially stiffened so that it vibrates at a frequency of about 500 per second, and is operated by the magnet a energized by the current supplied at g. The circuit, comprising the vibrator, the condenser c and the inductance l. is tuned to the frequency of 500 per second, or a harmonic. s is a secondary coil, led to a discharge circuit containing condenser and inductance suitable for high-frequency oscillations. The principal advantage of tuning the circuit cbl to the frequency of the vibrator is that there is no burning when the circuit is broken, because it can be arranged that at that moment there is no current flowing. The theory of the process is given in the specification and is of considerable interest. In Fig. 10 ox is the time axis and oy the current axis. Suppose the origin to correspond with the moment when the condenser c is fully charged and the gap is closed. If the gap were closed permanently, the condenser would discharge as indicated by the current curve *oabcd*—i. e., as a damped oscillation. At the same time the current from the mains g rises according to the ordinary exponen-

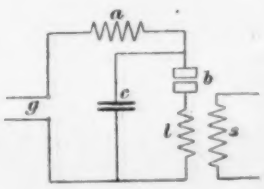


Fig. 9.

tial law, as shown by the curve *oefg*. The precise dimensions of the curves depend on the electrical dimensions of the circuits. When the current through the magnet

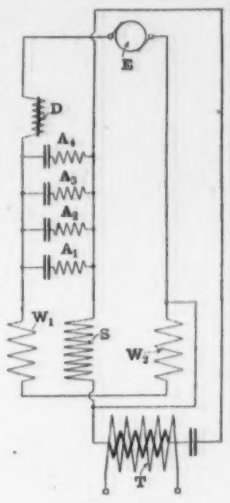


Fig. 4.

coil a rises to a certain value, represented, let us suppose, by the line at height oy, the contact is broken. Usually the current will rise to a slightly higher value before the interruption is completed, and this is shown in the figure. On adding the current curves, another curve, *ohkn* is obtained, which practically attains zero if nc equals nf. This state of things can be brought about by suitably varying the capacity in the circuit or by varying the inductance of the magnet coil a. But the currents

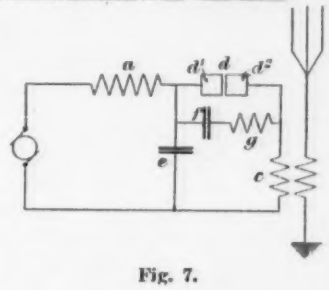


Fig. 7.

do not die away immediately. The supply current begins to charge the condenser c, shown in the diagram by the line fsp for the supply current, and the symmetrical line cqr for the condenser current, and this causes the contact to be maintained till ds is less than oy'. Experiments in adjusting the inductances a and l and the capacity c corroborate the theory adequately. In using the apparatus for producing oscillations for wireless telegraphy it is advisable to tune the secondary circuit, comprising the secondary of the inductorium s and the high-frequency condenser, to the frequency 500 per second, for the same reasons as hold good in the resonance transformer. The inventor claims for his apparatus the merit that it produces musical notes while being very efficient electrically.

(To be continued.)

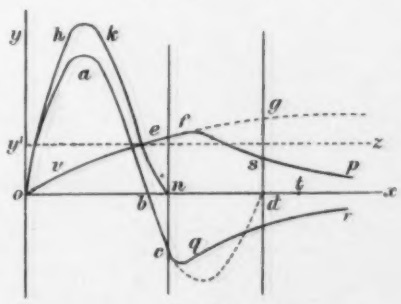


Fig. 10.

An Important Medical Expedition to the Far East has been undertaken by Dr. R. T. Leiper, helminthologist of the London School of Tropical Medicine, accompanied by Surgeon Atkinson, R.N., and Mr. Cherry-Garrard, both of whom were members of Capt. Scott's Antarctic expedition. The undertaking is subsidized by a grant from the Colonial Office, and its object is to study the mode of spread of trematode diseases of man, especially bilharziasis. The latter disease is due to a trematode worm (Bilharzia), and is particularly prevalent in Africa. More than one third of the inhabitants of Lower Egypt are known to suffer with it, and it was contracted by many British troops in South Africa during the Boer War. It also prevails in Porto Rico. The expedition is beginning its work in China. Investigations will be made later in Sumatra, where the United States Rubber Company has offered the party facilities for studying medical problems on the company's estates.

A New Copper Photographic Process.—Photographs upon copper plate are now made by a new process. It has been desired to use the sensitiveness of cuprous salts to light especially for transferring engraving designs upon metal, but such images could not be fixed, as reagents dissolve the copper salts, both acted on by light or unaffected, in about the same way. By a new process, a polished copper plate is exposed to chlorine for a few seconds to produce a sensitive layer, then it is exposed under a negative for ten minutes in sunlight, after which a positive image is seen. The sensitive layer should be extremely thin, as a thicker layer is less suitable and is found to be in some cases twenty times less sensitive. Fixing is readily done by a toning-fixing bath containing but little hyposulphite and already charged with silver salts coming from previous use with paper toning. On the plate, the affected parts take a brown hue and the rest dissolves out. Other baths can also be used. The image made by this process looks somewhat like a daguerreotype.

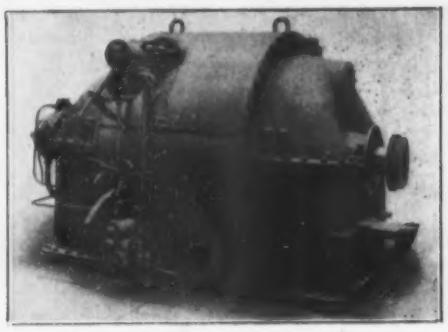


Fig. 1.—A view of the port turbine from the rear.

The Steam Turbine and Reduction Gear*

Propelling Machinery for the U. S. N. Collier "Neptune"

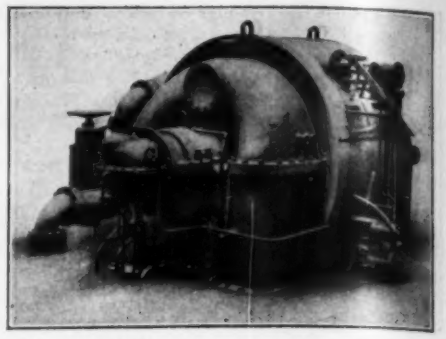


Fig. 2.—Port turbine, showing governor and oil relay cylinders.

WITH the introduction of gears between the turbine and propeller, a number of problems arise which were not met with in the direct arrangement. The use of gears permits the turbine to run at almost any desired number of revolutions and thus materially reduces the size and weight of the turbine for any given capacity.

With the direct connected arrangement, owing to the increase in weight and particularly the length of the turbine, it has been difficult to obtain a sufficiently large proportion of the ahead power in the astern turbine. In many cases where sufficient astern power was available, the small diameter of the propeller made this power of little benefit because the thrust in reversing rose to such a point that cavitation occurred and the propeller became ineffective.

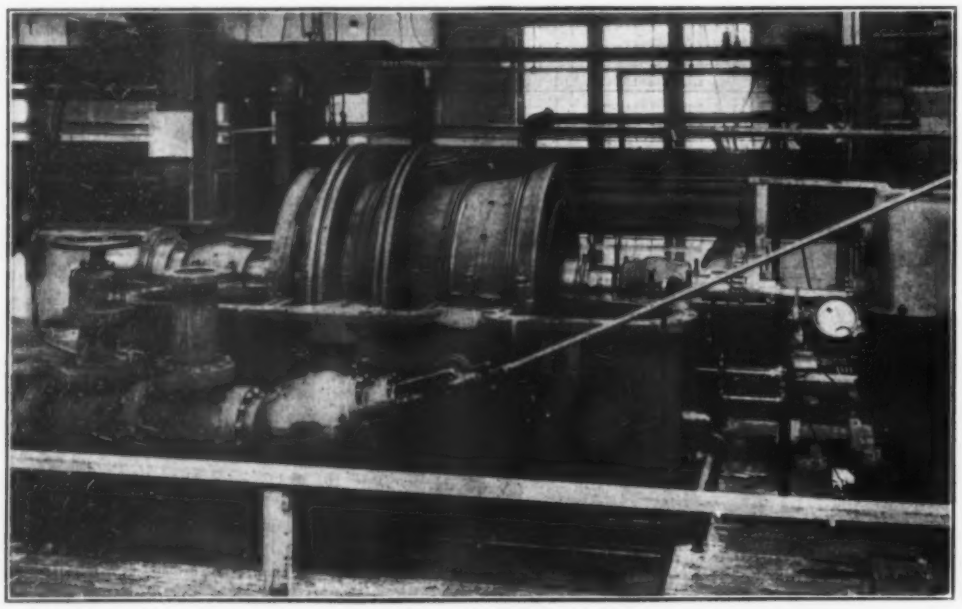


Fig. 3.—Turbine on test stand, with the cylinder blade rings removed.

With the geared installation, however, owing to the lower speed, the propeller can be made of such ample area that its efficiency, when reversing, is very much higher than that of a direct connected one. As a result of this higher propeller efficiency in the geared unit, a smaller proportion of the ahead power gives far better maneuvering qualities than a larger proportion of the ahead power gives in a direct connected installation.

This condition is rather fortunate for two reasons:

First—with the increased speed of the geared turbine, its economy is much higher than that of the direct connected unit. Owing to this lower water rate of the ahead turbine, it necessarily follows that the astern turbine (in order to develop a given percentage of power of the ahead on the same weight of steam and same steam conditions) must be designed to give practically as good a water rate as that of the ahead turbine in a direct connected installation. Therefore, to develop the same percentage of the ahead power, the astern turbine in a geared installation must be proportionately larger than in the direct connected unit.

Second—as the size and the speed of the turbine increases, the power absorbed in running the astern turbine idle increases very rapidly, so that the greater the proportion of the ahead power it is desired to develop when running astern, the more difficult it becomes to make the ahead turbine as economical as desired.

As the power required to drive the astern turbine idle increases with the density of the steam in which it is rotating it is obvious that it is more essential to maintain a high vacuum in a geared than in a direct connected installation; and the higher the vacuum which can be maintained at all times, the greater the proportion of the ahead power which it is permissible to develop when running astern. Likewise, if the astern turbine is designed to develop too great a proportion of the ahead power, the turbine becomes too long, with the attendant difficulties which this length involves.

Fortunately, however, in a geared turbine installation it is not necessary to develop more than 40 to 45 per cent of full power ahead when running astern, since the starting and stopping torque available for bringing the turbine to rest reaches a maximum value of from three to four times the ahead full load torque. It will be obvious, therefore, that a turbine capable of developing 40 per cent of the full power ahead, actually has a starting and stopping torque greater than the full load torque ahead. The maximum torque which a reciprocating engine can develop is equal to the area of the pistons into the mean effective pressure with cutoff at full stroke. Therefore, the turbine can be brought to rest and reversed more rapidly than the reciprocating engine. As the propeller speed in the geared turbine installation is about the same as that which would be used in a reciprocating engine vessel, the maneuvering qualities of a turbine with 40 to 45 per cent of the ahead power would be somewhat better than those of the reciprocating engine.

Advocates of the reciprocating engine may raise an objection at this point by calling attention to the fact that the energy stored in the turbine rotor and gear wheel exceeds that stored in the reciprocating parts of an engine. Though this is true, it is fortunate that the greater stopping torque of the turbine is sufficient to more than offset the greater stored energy.

Fig. 4.—Cross-section on center line of ahead high-pressure nozzles.

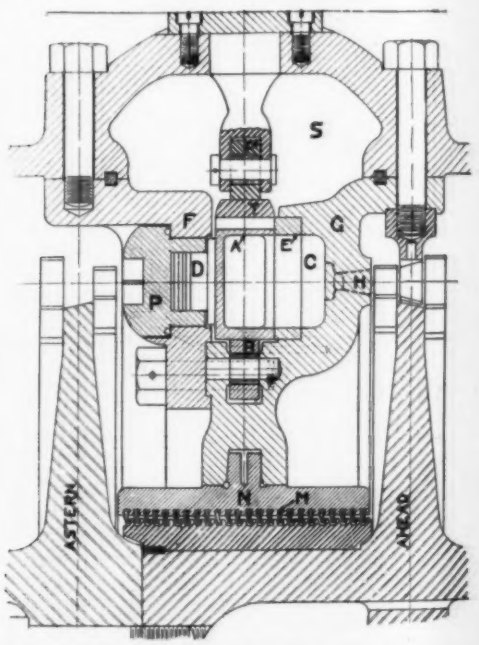


Fig. 5.—Partial longitudinal section through turbine, showing nozzle valve and nozzles.

The turbine has further the advantage that the torque at very low speeds is sufficient to revolve the propeller against its greatly increased resistance to turning at the instant of reversing, when the water flowing past it (owing to the motion of the ship) tends to keep it revolving, since the propeller then becomes a water turbine in effect, and it requires a prime mover *with the characteristics of a turbine* to overcome the greatly increased torque.

When running at full power, the links of a reciprocating engine may be thrown over as rapidly as the steam can be shut off from the ahead and on the astern turbine, but even when the links have been thrown over, the engine does not respond immediately, but first stalls, until the drag of the propeller and resistance of the hull have checked the velocity to the point where the engine can overcome the resistance of the propeller. In the turbine installation, however, the propeller begins to revolve in the opposite direction as soon as it has come to rest, so that even if the time required to bring the propeller to rest were the same, the turbine would still have a considerable advantage.

In general, an engineer would not dare to throw the links hard over, with full steam on, except in a very slow speed vessel of comparatively low power.

What has just been said regarding the effect of increase of power of the astern turbine on the economy of the

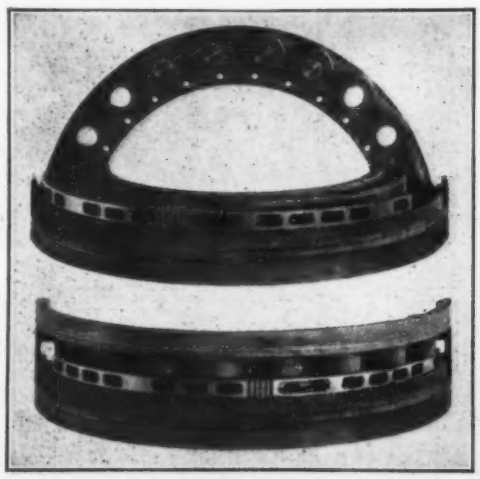


Fig. 6.—A nozzle block and sliding valve with four balance pistons.

Fig. 7.—Ahead nozzle block, slide valve and balance pistons completely assembled.

* By courtesy of the Westinghouse Machine Company.

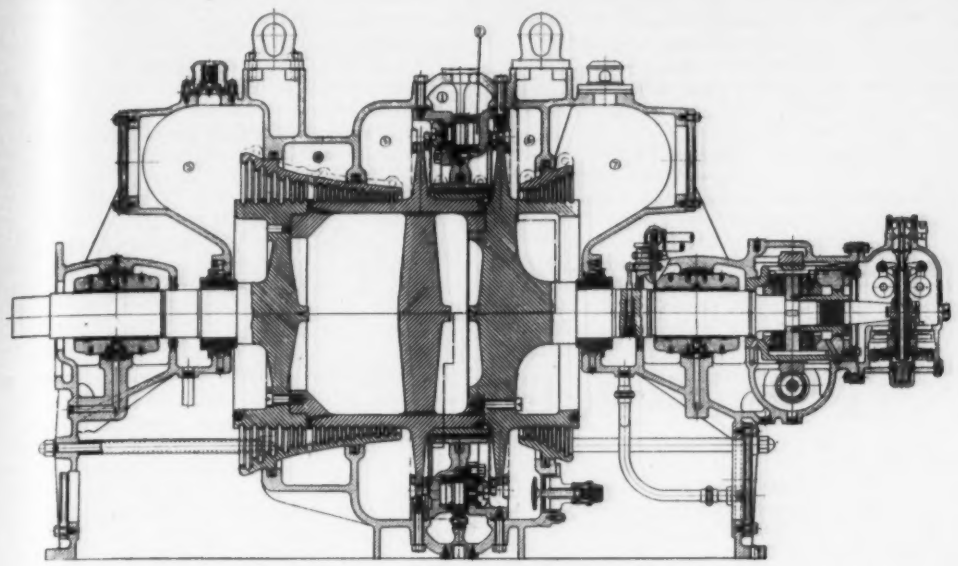


Fig. 8.—Cross-sectional elevation of assembled turbine.

ahead turbine, applies more particularly to a complete reaction turbine. Most of these disadvantages are obviated in the design adopted by the Westinghouse Machine Company by the substitution of an impulse wheel for the high-pressure portion of both the ahead and astern turbines.

In this design from 60 to 70 per cent of the full power ahead is used for the normal astern power where, in the opinion of the purchaser, it is deemed desirable, and in the case of the "Neptune" approximately 90 per cent of normal ahead power has been developed by the astern turbines. However, regardless of the normal astern power for which the turbine is designed, a greater proportion of the ahead power may be developed by using more steam, which, as a rule, is available since the astern turbine is only in use at intervals.

The use of the high-pressure impulse wheel instead of reaction blading in marine turbines, has two important purposes. First, it has a greater stopping torque, and second, permits the use of nozzle control.

The use of the impulse wheel, furthermore, materially shortens the ahead and astern turbines, thus making a more compact and lighter installation, and at the same time eliminating the short high-pressure reaction blades so that only a comparatively few rows of large substantial blades are required.

The use of the combination impulse reaction turbine has the advantage that complete ahead and astern turbines of high economy can be contained in a common cylinder, thus obviating, except under some unusual condition, the necessity of employing the cross-compound arrangement of turbines. Each turbine, whether two or more turbines are used to drive a common gear or independent gears, is a complete unit in itself and may be operated independently of other turbines. In twin or triple screw vessels, each engine room is thus complete in itself without any cross-connections and the attendant complication required to permit operating either high- or low-pressure turbine when either one or the other is out of commission.

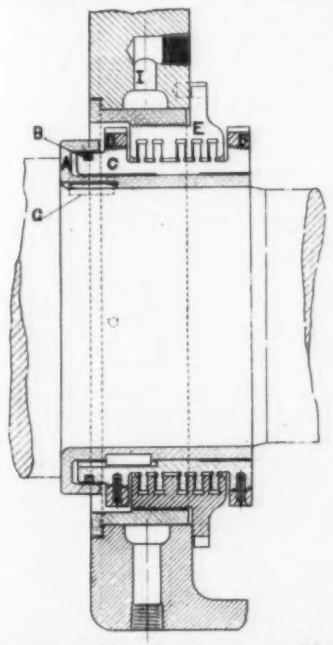


Fig. 10.—The turbine glands are a modified type of labyrinth packing.

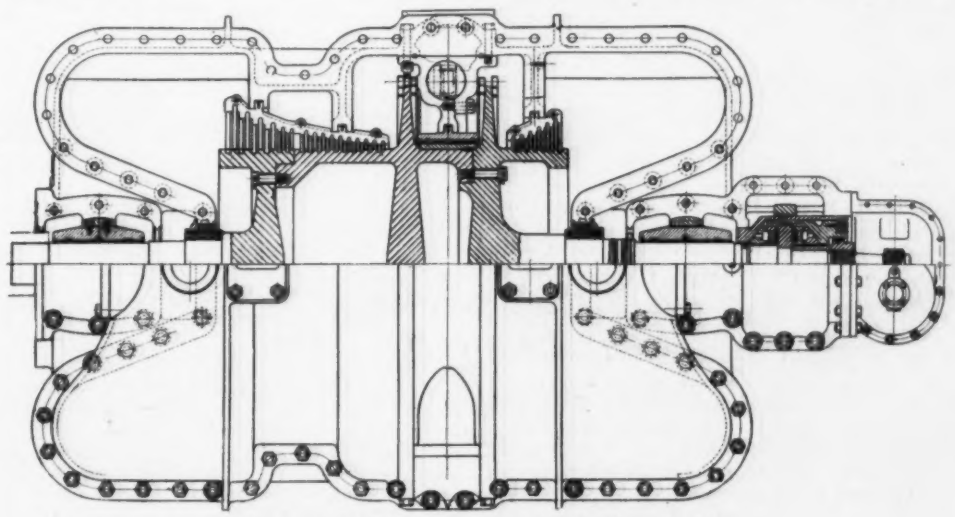


Fig. 9.—Semi-plan view and longitudinal section of turbine.

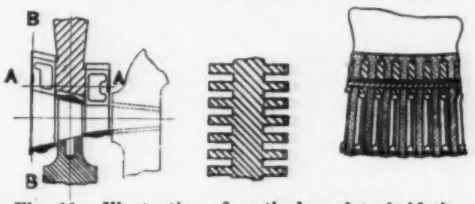


Fig. 11.—Illustration of method used to hold the impulse blades.

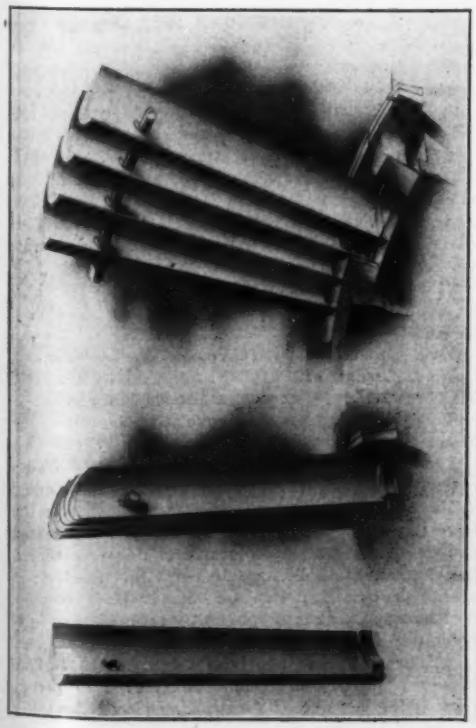


Fig. 12.—General view of blade attachment. The largest blades are held in place by wedges.

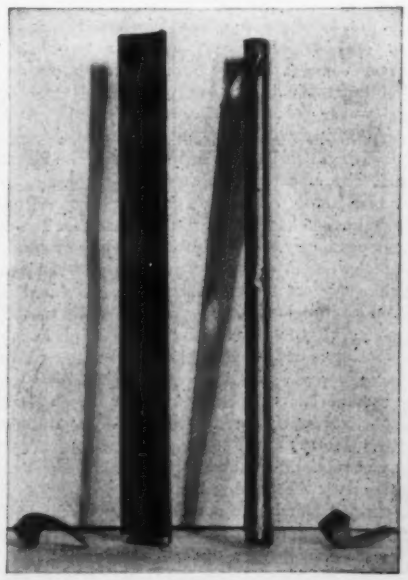


Fig. 13.—Details of new blade attachment. The blades are thickened about 50 per cent at the root.

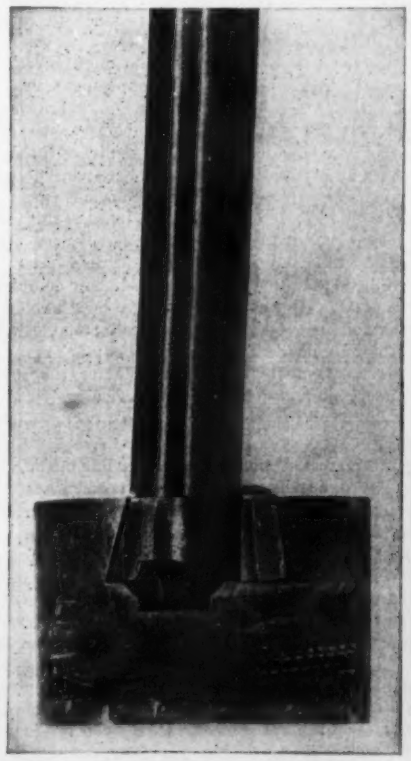


Fig. 14.—Cross section of model, showing undercut groove in which the ends of the blades fit.

The combination turbine, using the impulse and reaction elements, has a decided advantage over the pure reaction or pure impulse type of turbine, since, as previously mentioned, it obviates the short, frail blades of the high-pressure section of the pure reaction turbine and also obviates the troublesome diaphragms and interstage packings of the pure impulse turbine.

Though the impulse wheel is not as efficient as reaction blading, the advantages which result from its use are so important where high blade speeds can be employed, that its use is amply justified.

It is possible to so design an impulse wheel with two rows of blades that its efficiency will not fall off seriously when the steam velocity is only two to two and a half times the blade speed, and will remain nearly constant until the velocity of the steam reaches four to four and one half times the blade speed.

Thus by the use of nozzle control, the efficiency of the high-pressure portion of the turbine can be kept nearly constant over a considerable range of power and speed.

If we assume an initial condition of 200 pounds steam pressure and 550 feet per second blade speed for the impulse wheel, the steam velocity at full power may be as low as 1,200 feet per second, corresponding to a heat drop of 32 B.t.u. and expansion from 200 pounds absolute to 135 pounds absolute.

If we consider the power to vary as the cube of the revolutions per minute, then at 37.5 per cent of full power, the revolutions would be 72 per cent of those corresponding to full power; and if we further assume that it requires 40 per cent of full power steam to develop 37.5 per cent of full power at the reduced revolutions, the absolute pressure at the inlet to the reaction blading (which is directly proportional to the flow of steam) would be 40 per cent of 135, or 54 pounds absolute.

In expanding from 200 pounds absolute to 54 pounds absolute, 92 B.t.u. would become available, which, allowing for the nozzle efficiency, would correspond to a steam velocity of approximately 2,140 feet per second, and since this is but five and four tenths times the reduced blade speed, the falling off in economy of the impulse wheel would be but very slight.

It will be evident, however, that if the impulse blade speed is low, as in the case of some direct connected turbine installations, since the B.t.u. drop which can be efficiently provided for in the impulse wheel is very small (generally less than one fourth of those used in the above illustration), a comparatively small decrease in power, and consequent increase in heat drop, in the impulse wheel, very seriously decreases the efficiency.

With the impulse-wheel blade speeds possible in a Westinghouse geared installation, such a large range of heat drop can be efficiently employed, that economies only approached at full power in the past are possible at cruising speeds, and special cruising turbines are entirely unnecessary.

A difficulty which arises in the pure impulse marine turbine when designed for high speed in connection with reduction gearing, is that in order to avoid excessive length it is difficult to obtain hubs of sufficient length between the wheels of the various stages to entirely eliminate the danger of distortion of the disks and hubs by gyroscopic action of the disks at high speed. In connection with direct connected turbines, this has frequently been a subject of discussion, but owing to the fact that the bending moment set up in the shaft by the gyroscopic action of one disk neutralizes that set up by the adjacent disks, this has been considered of little importance, but the possibility of side swiping of the blades due to stretching of the hubs from this cause, has been entirely overlooked.

From the following illustrations and description, the reader will be able to judge for himself how completely the various objections referred to have been avoided in the design of the Westinghouse marine turbine, of which one form only is hereinafter described, a number of suitable arrangements being available for the several different classes and conditions of service.

DESCRIPTION.

Fig. 4 is a cross section on the center line of the ahead high-pressure nozzles, showing the nozzle valve and balancing pistons, and Fig. 5 is a partial longitudinal section through the turbine showing the nozzle valve and nozzles. The valve *A* is made of Monel metal, the valve seat *E* of cast iron and the balancing pistons *D* and retaining caps *P* are all made of bronze.

The nozzle valve proper *A* is moved by a rack which engages with gear teeth cut in the periphery *T* of the valve, by means of which it can be partially rotated.

To permit the movement of the valve with the least possible force, the valve is supported upon internal and external rollers *R* and *R'*.

The pressure of the steam on the valves is balanced by means of small pistons *D*, of which there is one for each pair of nozzles, there being 12 nozzles in the ahead and 16 nozzles in the astern. The space between the balancing pistons *D* and the retaining plugs *P* is connected to the space *C* of the second nozzle in each group of two; thus at any instant the unbalanced steam pressure can only be equal to the area of one of the ports in the valve *E*, admitting steam to the space *C*.

As will be readily seen from the developed cross section of the nozzle valves, the ports *B B* in the valve *A* and the ports in the valve seat *E* are so arranged that as the valve is moved to the left, the ports in *E* communicating with the nozzles are opened in succession, thus maintaining the full boiler pressure at the entrance to the nozzles, whether one or all of the nozzles are open.

In order to avoid leakage and distortion, the nozzle valve *A* is of rectangular section, cored out as shown in the developed section, Fig. 4, thus permitting the valve face to make a steam-tight joint at each port which is not open, while at the same time the box construction insures the circumferential rigidity necessary.

The main steam supply for the ahead opens into the space *S*, Fig. 5, in the lower half of the turbine cylinder, and steam for the astern opens into a similar space in the upper half of the turbine cylinder. Leakage from the space *S* into the turbine cylinder is prevented by dowel rings as shown.

As will appear later, there is but one dummy in the turbine, which divides the high pressure ahead from the astern turbine. This is shown in detail in Fig. 5. The dummy cylinder ring is a separate casting, which is supported from the nozzle ring *G*. The dummy strips are of the standard type employed in all Westinghouse turbines, and are 24 in number.

Fig. 6 shows one of the ahead nozzle blocks and

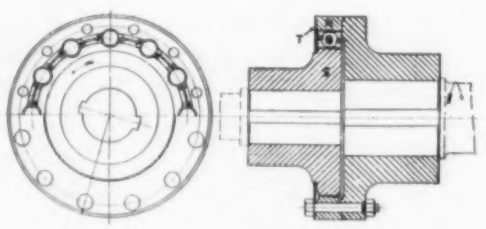


Fig. 15.—Special flexible coupling.

sliding valve partly assembled, and also four of the balance pistons in place. Fig. 7 shows an ahead nozzle block, slide valve and balance pistons completely assembled ready to put in the turbine casing.

A cross-sectional elevation of the completely assembled turbine is shown in Fig. 8. It will be noted that the turbine spindle is made in three parts, these being steel castings, one of which forms the forward spindle end and astern impulse wheel and reaction drum. The middle section of the spindle forms the ahead impulse wheel and part of the ahead reaction drum, the remaining part of the reaction drum and after spindle end being formed in a separate piece. The various parts of the spindle are bolted together. This spindle construction is unusually rugged and heavy for marine work, but it is partly necessitated by the comparatively high blade speed of the impulse wheels, which is 525 feet a second at full power. As the effective mean diameter of the ahead and astern reaction sections of the turbine are the same, a single dummy located between the two impulse wheels serves for both the ahead and astern reaction sections. However, any slight unbalanced end thrust which may arise in either the fore or aft direction is amply taken up by a Kingsbury thrust bearing, which is clearly shown in the longitudinal cross section. It will be recalled that the Kingsbury thrust bearing consists of a number of independent babbitted shoes, each supported on a spherical seat formed in a ring, which itself is spherically seated in the bearing housing, thus permitting each shoe to adjust itself independently so as to obtain a uniform bearing pressure over its entire surface, and the spherical seating of the shoe supporting ring permits the individual shoes to distribute the load equally among each other. A single collar on the shaft thus serves in place of the numerous collars used in the older type of thrust adjusting bearing.

The turbine bearings are of the standard Westinghouse spherical seated type, with loose keys and shims, permitting centering the turbine spindle without the necessity of rebabbitting and boring the bearings exactly concentric with the bearing housing.

The turbine glands are a modified type of labyrinth packing, as shown in Fig. 10, consisting of a brass sleeve *A* on the shaft, in which a snap ring *B* fits and packs the sleeve *C*. The sleeve *C*, which is made in halves, is held together by the rings *DD*, which are screwed on tapered threads. The sleeve *C* fits snugly, but not tight, on the sleeve *A* and rotates with the shaft, but end movement of the sleeve *C* relative to the shaft is permitted so that the collars of the sleeve *C*, which fit in the bushing *E* with a few thousandths clearance, will not bind or press too heavily against the bush *E* when the spindle moves endwise from expansion or in taking up the slight end motion of the spindle in the thrust adjustment bearing. A feather key *G*, partly recessed in the sleeve *A* and partly in sleeve *C*, drives the latter with the turbine shaft.

The bushing *E* is screwed into a second bushing, as shown, thus permitting the whole stuffing box to be removed from the turbine without removing the turbine cover. Steam for sealing and lubricating the labyrinth is supplied through the inlet *I*.

The stationary reaction blades instead of being held in the turbine cylinder proper, as is customary in marine turbines, are held in loose cast steel rings, which are doweled in the turbine cylinder so that they can be easily removed. This obviously permits the carrying of spare rings, bladed ready for use, thus facilitating rapid repairs in the event of damage to either the ahead or astern reaction blading. The loose reaction blade rings are clearly shown in Fig. 3, which shows the starboard turbine on the test floor with the upper half of the turbine casing removed.

The auxiliary steam inlet to the ahead reaction blading connects into the space 4, Fig. 8, and through the holes shown in the reaction cylinder blade rings to the low-pressure ahead blading. The pressure at the point of admission of the auxiliary exhaust is about 16 pounds absolute at full power.

The valve shown, connecting the astern impulse wheel chamber with the condenser, is provided to permit the escape of any steam leaking past the dummy when running ahead without the necessity of its passing through the astern reaction blading, and thus causing additional lost work. This is one of the decided advantages of the impulse wheel when used in this manner, as the steam leaking by the dummy cannot cause any additional resistance in the astern impulse wheel when the turbine is running ahead. By-passing the reaction blading obviates any loss at this point. This by-passing valve is operated automatically by a piston resisted by the spring, which normally holds the valve in an open position, as shown, but as soon as steam is admitted to the first astern nozzle, the pressure back of the piston brings the valve to its seat.

An automatic stop of the usual type fitted on all Westinghouse turbines is provided. The automatic stop plunger in the spindle trips a valve which releases the steam pressure under the piston of the automatic stop valve in the main steam line, the automatic stop valve being placed ahead of the control valve so that it serves for both ahead and astern operation.

Fig. 9 is a semi-plan view and longitudinal section of the turbine.

Fig. 11 shows the method employed to hold the impulse blades. As will be seen from the illustration, slots are cut in the narrow rim on each side of the impulse disk and T-headed shanks on the blades are fitted in these slots, the blades thus being literally hung on a cantilever projecting from the impulse wheel disk. A groove is turned in each side of the projecting cantilevers, in which calking pieces are inserted, one of these being dovetail and the other flat. The purpose of these is solely to hold the blades from moving sidewise in the slots. This construction permits making the blade attachment as strong as the cross section of the blade itself, and at the same time reduces the weight of the rim supporting the blades to a minimum and simplifies the distribution of stresses at the rim materially. There is no change from hoop stress to disk stress as the slots eliminate the tangential stress ordinarily existing in the rim.

In the past few years an entirely new method of blade attachment has been developed by the Westinghouse Machine Company, in which all dependence upon the frictional grip on the blades is eliminated. This new blade attachment is illustrated in Figs. 12, 13, 14. Fig. 14 is a cross section of a model, which shows the undercut groove and a second smaller groove at the bottom of the primary groove, in which the upset ends of the blades fit.

As will be noted in Fig. 13, the ends of the blades are thickened by upsetting on a gradual taper extending from one to three or four inches from the root of the blade, the actual section of the blade being increased about 50 per cent at the root, and at the same time a lip is formed which hooks under the dovetailed shape packing pieces shown. In the smaller blade sections the packing pieces are slipped in by turning them sidewise in the groove until all the blades have been inserted except one or two where the undercut in the turbine cylinder blade ring or spindle is removed to permit inserting the last one or two packing pieces, the space cut out of the dovetail for this purpose being finally filled with a soft calking piece.

In the case of the very largest blades, where it is undesirable to remove part of the undercut of the

spindle groove, the blades are held in place with double wedges, as shown in Fig. 12. The same form of comma lashing wire, which has been so successfully employed by the Westinghouse Machine Company, has been retained in the marine turbines.

The upsetting of the ends of the blades and tapering of the normal section toward the tip of the blades very materially increases the resistance of the blades to bending stresses, and also to those very serious stresses arising from vibration; and whereas in all other forms of reaction blading attachments the weakest section of the blade is where it meets the cylinder or spindle, this is the strongest point of the blade in the Westinghouse design. This is very clearly shown by the fact that when the lip, Fig. 13, is gripped in a vise and the end of the blade subjected to a bending pressure, the first indication of any bending whatever occurs some two or three inches from the lip in long blades and, of course, at a somewhat shorter distance from the lip in very small blades. The result of this method of blading is that even most serious rubs between the blades and stationary portion may be encountered without any damage to the blades other than burring of the ends.

In order to permit the gear pinion to float longitudinally without imposing any end thrust on the teeth of the pinion or gear, a special flexible coupling was designed by Mr. Westinghouse, which is illustrated in Fig. 15. As will be seen, the coupling consists simply of two flanged collars, one on the turbine and one on the pinion drive shaft, and a ring R bolted to the portion of the coupling on the turbine shaft. There is a slight clearance between the ring R and the hub S, and the driving force is transmitted through the ring R to the hub S by means of steel balls B, which are inserted in holes drilled partly in the ring R and partly in the hub S. These holes are lined with hardened steel bushings made in halves, and the balls are retained from coming out of the hole by means of the retaining ring T. As will be seen, this coupling is extremely simple and facilitates taking the turbine spindle or pinion out without disturbing any other part. After extended service it has proved itself entirely satisfactory for this work.

The Racial Origin of Successful Americans*

The Dominance of the Anglo-Saxon

By Dr. Frederick Adams Woods

THE New York "World Almanac and Encyclopedia" for 1914 gives a table showing the commonest surnames at the present time in England and Wales, Scotland and Ireland, arranged in the order of their frequency, according to a compilation made by the London *Pall Mall Gazette*, also the fifty commonest names in the cities of New York, Chicago, Philadelphia and Boston specially compiled for the "World Almanac." A person's last name is not always an indication of race or nationality, but the following names which are here arranged in their order of frequency as they occur in England and Wales certainly have a thoroughly English sound: Smith, Jones, Williams, Taylor, Davies, Brown, Thomas, Evans, Roberts, Johnson, Wilson, Robinson, Wright, Wood, Thompson, Hall, Green, Walker, Hughes, Edwards, Lewis, White, Turner, Jackson, Hill, Harris, Clark, Cooper, Harrison, Ward, Martin, Davis, Baker, Morris, James, King, Morgan, Allen, Moore, Parker, Clark, Cook, Price, Phillips, Shaw, Bennett, Lee, Watson, Griffiths, Carter.

In contrast to this list, the English-sounding names sink to perhaps less than 10 per cent in Ireland. Probably a large proportion of these Anglo-Saxon names belong to the Protestant Irish of Ulster county. The order of frequency for Ireland as a whole is Murphy, Kelly, Sullivan, Walsh, Smith, O'Brien, Bryne, Byrne, Connor, O'Neill, Reilly, Doyle, McCarthy, Gallagher, Doherty, Kennedy, Lynch, Murray, Quinn, Moore, McLaughlin, Carroll, Connolly, Daly, Connell, Wilson, Dunne, Brennan, Burke, Collins, Campbell, Clarke, Johnson, Hughes, Farrell, Fitzgerald, Brown, Martin, Maguire, Nolan, Flynn, Thompson, Callaghan, O'Donnell, Duffy, Mahony, Boyle, Healy, Shea, White. It seems that there are only about nine names of English origin out of these fifty and with the exception of Smith none are high in the list.

In New York city, Chicago, Philadelphia and Boston, the Irish, German, Scandinavian and Jewish elements are recognizable in Murphy, Kelly, Cohen, Levy, Cohn, etc. Immigration has been going on for a number of years, and we may ask to what extent these more recently arrived races have risen to positions of national importance or distinguished themselves in professional life. The compilation "Who's Who in America" endeavors to include, if not the best, at least "the best-known men and women of the United States." The standards of admission divide the eligibles into two classes: (1) "those who are selected on account of special prominence in creditable lines of effort, making them the subjects of extensive interest, inquiry or discussion in this country; and (2) those who are arbitrarily included on account of official position—civil, military, naval, religious or educational." The arbitrary class embraces, without regard to notability or prominence in any other respect, the following: all members of Congress; all governors of States, territories and island possessions of the United States now in office; all United States judges; all judges of State and territorial courts of highest appellate jurisdiction; members of the Cabinet; Federal department heads; all officers of the army above the rank of colonel, and all of the navy above the rank of captain; all American ambassadors and ministers plenipotentiary; heads of all the larger universities and colleges; members of the National Academy of Sciences and of the National Academy of Design; heads of all the leading national societies devoted to educational and scientific aims; bishops and chief ecclesiastics of all the larger religious denominations in the United States; and those who are in like manner chosen because of their official relations and affiliations.

In the tables below I present the lists of the most frequent names in New York, Chicago, Philadelphia and Boston, as drawn from the "World Almanac" for 1914, and opposite each, the number residing in each city

COMMON NAMES IN AMERICAN CITIES AND NUMBER BEARING THE NAME IN "WHO'S WHO IN AMERICA," 1912-13.

New York city		Chicago		Philadelphia		Boston	
Smith	27	Johnson	4	Smith	7	Smith	8
Brown	13	Smith	7	Miller	4	Sullivan	1
Miller	16	Anderson	2	Brown	4	Murphy	1
Murphy	5	Miller	6	Jones	6	Brown	11
Meyer	3	Brown	6	Johnson	5	Johnson	3
Johnson	9	Peterson	0	Wilson	6	Clark	3
Kelly	4	Jones	2	Kelly	0	O'Brien	1
Cohen	1	Williams	3	Williams	4	McCarthy	0
Levy	1	Wilson	6	Taylor	5	White	2
Williams	13	Thompson	4	Davis	3	Davis	0
Jones	8	Olson	0	Moore	3	McDonald	0
Murry	2	Davis	4	Clark	2	Williams	6
Wilson	7	Ryan	0	Murphy	1	Jones	1
Clark	9	Clark	2	Thompson	1	Kelly	0
Sullivan	2	White	2	Dougherty	0	Hall	3
Martin	8	Kelly	2	Young	2	Taylor	2
White	13	Martin	2	White	6	Doherty	0
Davis	7	Moore	5	Martin	1	Wilson	1
O'Brien	1	Schmidt	0	Thomas	1	Kelly	0
Ryan	3	Sullivan	2	Campbell	1	Donovan	0
Moore	5	Meyer	2	Gallagher	0	Murray	1
Schmidt	0	Murphy	1	Robinson	1	Collins	0
Taylor	9	O'Brien	0	Myers	0	Robinson	1
Muller	1	Hansen	0	Scott	2	Moore	1
Thompson	7	Larsen	0	Anderson	0	Anderson	2
Anderson	4	Taylor	2	McLaughlin	0	Allen	5
Walsh	3	Walsh	0	Allen	0	Thompson	2
Harris	6	Young	3	Green	1	Hill	3
Reilly	0	Campbell	1	Fisher	2	Ryan	0
Campbell	1	Lewis	2	Walker	1	Miller	0
O'Connor	1	Mueller	0	Morris	4	McLaughlin	0
King	2	Baker	5	Stewart	1	Walsh	0
Lynch	3	Adams	3	Wright	1	Mahoney	0
McCarthy	0	McCarthy	0	Mitchell	3	Fitzgerald	1
Schneider	1	Hall	6	Murray	1	Young	0
Lewis	9	Jackson	2	Hughes	1	Parer	2
Ward	7	O'Connor	0	Lewis	3	Lynch	0
Young	6	Hill	4	Fox	2	Campbell	2
Robinson	5	Burke	1	O'Brien	0	Martin	0
Hall	13	Allen	1	King	0	Rogers	2
Brady	3	Olsen	0	Evans	0	Baker	1
Burke	2	Hoffman	0	Roberts	4	Foley	0
Morris	5	Green	1	Jackson	1	Wood	1
Collins	3	Murray	0	Harris	1	Stevens	1
Jackson	7	Lynch	0	Collins	0	Morse	5
Carroll	2	Becker	0	Snyder	1	Crowley	0
Allen	13	Peterson	0	Kennedy	0	Lewis	1
Hughes	0	Ward	2	Wood	4	Barry	0
Klein	2	Morris	2	Hall	0	Burke	0
Cohn	2	Schneider	0	Burns	0	Driscoll	0

who are included in the 1912-1913 edition of "Who's Who in America."

Other names of five or more of the same name in "Who's Who" residing in New York, but not included in the above, are Abbott, Adams, Alexander, Baker, Chapin, Clarke, Cooper, Curtis, Davis, Eaton, Fiske, Foster, Fuller, Gilbert, Greene, Holt, Johnston, Lawrence, Lee, Merrill, Mitchell, Morgan, Morse, Norton, Parsons, Perry, Phelps, Porter, Post, Putnam, Richards, Russell, Scott, Stokes, Thomas, Vanderbilt, Walker, Warren, Wood.

All these with the exception of Scott, which is a characteristic Scottish name, and Vanderbilt, which is Dutch, are characteristically English names. It would seem that the original Dutch element has not maintained itself in general leadership in New York. The English element has. I suspect that much of the concentrated eminence now in New York city is due to migration of New England strains from Connecticut and Massachusetts, which States I have already shown to lead in proportion to their population in all forms of creditable activity, and no matter what be the criterion of distinction.[1]

If these 50 commonest names in New York city are arranged in the order in which they are most common on the other side of the Atlantic, 19 of these names will fall to England and Wales, 8 to Scotland, 15 to Ireland, while 8 are characteristically German or Jewish. The 19 English furnish 168 in "Who's Who." The 8 Scotch 57, the 15 Irish 37, the 8 German or Jewish furnish only 11. Thus it appears that while the Irish and Jewish elements in New York may control politics and the wholesale and retail trade, they have not often risen to high positions.

In Chicago the German, and particularly the Scandinavian elements, naturally show themselves in the surnames. Smith is even outdone by Johnson (here probably to a large extent Scandinavian). Anderson beats Miller and Peterson beats Jones, Olson is commoner than Davis and appears again as Olsen. Irish names are fairly common, Jewish names are not. The names not of English origin in the above list furnish 12 distinguished Chicagoans against 80 with characteristically English names. Other names of Chicago people occurring in "Who's Who in America" in blocks of four or more are Webster, Black, Carpenter, Cole, Evans, McCormick, Mathews and Stone. Not a single foreign name occurs frequently. Crediting each common name in Chicago to the European country in which it is most common and leaving out Johnson and Anderson as doubtful cases, the distribution and number in "Who's Who" is as follows: 18 English names furnish 59 distinguished individuals; 7 Scotch, 24; 11 Irish, 11. The 12 Germans, Jewish, Scandinavian or other common names furnish none!

In Philadelphia (of the 50 commonest names) 32 characteristically English names total 86 distinguished persons, 18 non-English total only 7. Crediting each common name to the "Old Country" in which it is most common, we find the distribution is England and Wales 28 names with 45 in "Who's Who in America." Scotland 11 names with 18; Ireland 9 with 4, and 2 other countries with 1 each.

For Boston the facts are a little startling. It seems almost unbelievable that the Irish making up more than half the population of the city, many of whom represent the second and third generation (for the Irish began to come to Boston in large numbers as early as 1830), can furnish only about two dozen persons entitled to national recognition.

According to "Who's Who in America," there were no persons in Boston entitled to inclusion at the beginning of the year 1912 bearing the most common names of McCarthy, Davis, McDonald, Kelly, Doherty, Kelley, Donovan, Collins, Ryan, Miller, McLaughlin, Walsh, Mahoney, Young, Lynch, Martin, Foley, Crowley, Barry, Burke and Driscoll. Four of these names are Anglo-Saxon in origin, 3 are common to both the Scotch and Irish, and 14 are essentially Celtic. Among the 50 commonest names in Boston found in "Who's Who," those of Anglo-Saxon origin total 64 distinguished representatives, those of Celtic only 5. There should be about the same number of Anglo-Saxon and of Celtic, since 20 of these common Boston names are Celtic to 26 Anglo-Saxon and about half the present population is Catholic Irish. Looking at the matter another way and crediting all of each name to that country of origin in which the name occurs most frequently, or highest in the *Pall Mall Gazette* list, we find England and Wales 21 names credited with 55; Scotland 8 names credited with 14; Ireland 21 names credited with 5 distinguished, or more strictly speaking, widely-known Americans now residents of Boston.

It is true that people of non-English origin often change their names, making them more attractive to American ears, a Schneider becomes a Taylor, a Weiss a White, or even a Solomon Levi may become a Sydney Lee. But I do not believe that such changes can have had any appreciable effect on the present investigation

* Reproduced from the *Popular Science Monthly*.

[1] "Historimetry as an Exact Science," *Science*, April 14th, 1911.

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and none at all on the conclusions. I do not believe that more than a very small proportion of these persons in "Who's Who in America" who have English names have acquired their names in any other way than by natural descent. For the Boston statistics, I have been able to test this question by personal knowledge of the individuals or from genealogical inquiries. I know of two cases of notable foreigners bearing English names, one a Portuguese and one a Jew; but out of the 851 Bostonians in "Who's Who," I am very sure that not 5 per cent, probably not 1 per cent, have English names by change from a foreign one. I have made a special test of the Boston names and find out of 851 persons, that (bearing in mind the possibility of slight further readjustments) they must be classified as 19 Irish, 10 North Irish, 30 various European names and doubtful cases and 786 of true English or Scotch origin.

Thus to summarize: In the four leading American cities, New York, Chicago, Philadelphia and Boston, it is safe to say that, at the present time, those of English and Scotch ancestry are distinctly in possession of the leading positions, at least from the standpoint of being widely known, and that, in proportion to their number, the Anglo-Saxons are from 3 to 10 times as likely as are the other races to achieve positions of national distinction.[2]

The cities contain most of the foreign elements. The cities are also the concentration points for most types of ability. They are also the breeding grounds of future leaders.[2] Therefore this study of the four cities ought to suffice to throw light on a number of important questions.

The truth of the matter is that all the stocks that have come into America in recent years, since 1830, have been very inferior to those already here in the seventeenth and eighteenth centuries; and in general they have been getting worse and worse. There have been a few notable exceptions, but, broadly speaking, all our very capable men of the present day have been engendered from the Anglo-Saxon element already here before the beginning of the nineteenth century. We sometimes read magazines and newspaper articles about the Irish in America, the Germans in America, the French in America, the Jews in America, describing the achievements of distinguished foreigners who have risen to high esteem and publishing portraits of the same. It is because they are relatively few that it is possible to make a magazine article out of the material. Who ever saw a similar article on the English in America? The statistically true can be exciting only to the scientifically inclined.

We have heard a great deal about the "Melting-Pot," but no one as far as I know has brought forward any proof that there is a Melting-Pot in true biological sense, i. e., that there is any genuine mingling of blood sufficient to overcome the natural tendency that all species and varieties have to grow apart and become more dissimilar in course of time. If there had been a thorough mingling of the races in this country, there would have already been a decline in natural ability, but the tendency of like to mate with like, the natural tendency of the most successful to mate among themselves, works in the opposite direction. The real strength of a country is so dependent on the qualities of its leaders that it behooves patriots, sociologists and philosophers to take all these questions into account and consider more carefully the genesis and significance of that small fraction of one per cent which represents the intellectual crust.

How to Construct a Poultry House

POULTRY houses may be built more open and consequently less expensively in our Southern States than in the North, according to investigators of the U. S. Department of Agriculture. However, a house which gives satisfaction in Maine will also give good results in Texas or California. The best site for a poultry house in any location is one where good water and air drainage are available. The floor and yards will then be dry. The house should not occupy a low hollow in which cold air settles. Wherever possible, a southern or southeastern exposure should be selected, although this is not essential if there is any good reason for facing the house in a different direction.

"Poultry House Construction" is the title of the Department's new Farmers' Bulletin (No. 574), in which are explained the main features that should be considered, and in which pictures and plans of satisfactory houses are shown. Every poultryman who contemplates erecting new poultry buildings is urged to write to the Department for this Bulletin, which will be sent him free on application, as long as the Department's supply lasts.

THE "INTENSIVE SYSTEM" AND THE "COLONY SYSTEM."

There are two popular ways in which to raise poultry, the "intensive system" and the "colony system." The first of these aims to save steps, and accomplishes this purpose. Long stationary houses are used. It is easier, however, to keep the birds healthy and to reproduce the stock under the second system.

Under the colony system the birds are allowed free range, the houses, which hold about 100 hens each, being placed from 200 to 250 feet apart, so that the stock will not kill the grass. This system may be adapted to severe Winter conditions by drawing the colony houses together in a convenient place at the beginning of Winter, thus reducing the labor during the cold months. The first system is more suited for hens used solely for the production of market eggs than for those used to breed stock.

AS FEW FENCES AS POSSIBLE.

Fences mean an outlay of money, and this outlay is more or less continuous, as they must be maintained after being installed. There should be as few fences as possible dividing the lots and the yards, as land can be kept "sweet" more easily if not fenced, and fresh, sweet land is a valuable asset in poultry raising.

On good soil, a greensward may be kept up by allowing 200 to 250 square feet of land per bird. This means 174 to 217 birds per acre. More space is necessary on poor or light land. A larger number of fowls are usually kept to the acre where double yards are used and the land is frequently cultivated. Plymouth Rocks and the other heavy meat breeds in small yards require fences 5 to 6 feet high, while a fence 6 to 7 feet high is necessary for Leghorns. The upper 2 feet of the fence for the latter may be inclined inward at an angle of 30 degrees, or a strand of barbed wire may be used on top of the regular wire to keep them confined. It is also sometimes necessary to clip the wing feathers of one wing of these birds that persist in getting out. A board or strip along the top of the fence is not advisable. Hens will often fly over such an arrangement.

Posts may be set or driven into the ground. They should be set 8 to 10 feet apart with common poultry netting, or 16 to 20 feet with woven wire. Corner posts should be about 8 inches in diameter, and be set 4 feet in the ground, while intervening posts may be 4 or 5 inches in diameter and set 3 feet in the ground. That part of the post which is set in the ground may be charred or treated with some wood preservative to advantage, while corner posts should be firmly braced or set in cement.

PAINT ADDS BOTH TO APPEARANCE AND SERVICE.

All buildings and appliances on a poultry farm will be improved greatly, both in appearance and in serviceability, by the addition of paint. One may buy ready-mixed paints, or may purchase paste pigments and oil and mix them. All surfaces should be clean and dry before they are painted. Use a priming coat made of equal parts of paint and linseed oil and cover with one or more coats of paint, which should be thoroughly rubbed into the surface.

Whitewash is the cheapest of all paints, and may be used either for exterior or interior surfaces. It can be made by slaking about 10 pounds of quicklime in a pail with 2 gallons of water, covering the pail with cloth or burlap, and allowing it to slake for one hour. Water is then added to bring the whitewash to a consistency which may be applied readily.

A weatherproof whitewash for exterior surfaces may be made as follows: (1) Slake 1 bushel of quicklime in 12 gallons of hot water; (2) dissolve 2 pounds of common salt and 1 pound of sulphate of zinc in 2 gallons of boiling water; pour (2) into (1), then add 2 gallons of skim milk and mix thoroughly. Whitewash is spread lightly over the surface with a broad brush.

Electrical Uses of Tungsten

ALTHOUGH a chemistry textbook issued only a few years ago refers to compounds containing tungsten as being "numerous, complex and not of any commercial importance," a number of applications have been found for this metal since it became generally used in the filaments of incandescent lamps. Tungsten has been utilized with advantage in the anodes of X-ray tubes, its high melting point enabling it to withstand the cathode bombardment and to undergo temperatures which make present high-speed skiagraphy possible. It is also used in electric furnaces, both in the form of strips for winding coils and in tubular form. At high temperatures it is recommended that the metal be kept in a vacuum or surrounded by hydrogen, nitrogen or some other gas which does not act upon it. Tungsten has been widely used for sparking points and other electrical contacts. Some automobile manufacturers have even adopted tungsten throughout for all electrical contacts. Wrought tungsten has been hardened to such a point that it scratches glass yet remains ductile. Tungsten gauze is used successfully for separating solids from acid liquids, and tungsten metal should be in demand for acid baths in manufacturing processes. An important property of the metal is its insolubility in most common acids, including hydrochloric and sulphuric acid, although hydrofluoric acid and nitric acids will attack it. The melting point of tungsten is 3,100 deg. Cent. and its tensile strength is approximately 500,000 pounds per square inch. It is a very heavy metal, having a specific gravity of 20. The principal ore of tungsten is wolframite, a combination of tungsten and iron salt. This ore, when heated with sodium carbonate, produces tungstic acid, which is later reduced to tungstic oxide. Pure metallic tungsten is gray in color.—*Electrical World.*

THERE are approximately 4,000,000 acres of timber land in New Hampshire, of which about one half is in farmers' wood-lots.

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[2] It is not possible to express this ratio accurately without a great deal of labor. Since the commonest names of all, Smith, Brown, Miller, Johnson, Sullivan, etc., are, on the whole, more English than foreign, all names cannot be given the same weight. It would be necessary to go through the directories, count the names and thus get the separate weights for each name.

[2] See F. A. Woods, "City Boys versus Country Boys," *Science*, April 9th, 1909; and "The Birthplaces of Leading Americans and the Question of Heredity." Mr. Spillman's side of the case should also be read, though his statistics seem to me to be meager. Galton for English scientists and Odin for French *littérateurs* have both found city-birth predominant.